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ENGINEERING DATA TRANSMITTAL

Page 1 of 1

1. EDT 108239

2. To: (Receiving Organization) RLJ File/LCS File/LB

3. From: (Originating Organization) D. C. Weekes / B.A. Williams, Geosciences Group (80232)

4. Related EDT No: NA

5. Proj/Prog/Dept/Div: W80232

6. Cog/Proj Engr: R. L. Jackson

7. Purchase Order No: NA

8. Originator Remarks: Review comments shall be recorded on the attached RCR Form and returned to Mr. D. C. Weekes at his office at the close of business on October 25, 1989. THE ATTACHED GWMP IS UPDATED TO INCLUDE RCR'S AND ECOLOGY'S COMMENTS 1-18-90
ECOLOGY'S COMMENTS ARE IN ATTACHED REDLINE COPY + MEETING MINUTES, 1ST PAGE LAST PARA.

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10. System/Bldg/Facility: NA

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13. Permit/Permit Application No: NA

14. Required Response Date: 10/25/89

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev No.	(E) Title or Description of Data Transmitted	(F) Impact Level	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	~~Draft 0~~ WHC-SD-EN-AP-015	NA	~~NA~~ 0	Interim-Status Ground-Water Monitoring Plan for the 216-S-10 Pond and Ditch	2	4		

16. KEY

Impact Level (F)	Reason for Transmittal (G)	Disposition (H) & (I)
1, 2, 3, or 4 see MRP 5.43 and EP-1.7	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Impact Level for required signatures)

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4/1	1	~~Cog. Proj. Eng.~~ R. L. Jackson		2/6/90	H4-56	D. A. Turner	for D.A. Turner	2-5-90	H4-56	4	4
4/1	1	Cog./Proj. Eng. Mgr. K. R. Fecht		2/6/90	H4-56	C. E. Hodge	(PROJ ENG)			4	4
4	5	QA D. H. Jones	for D.H. Jones	2/7/90	H4-16	D. R. Schelt		2/1/90	H4-56	4	4
4	5	Safety ~~G. G. Meade~~ D.J. Alexander		2-6-90		L. C. Swanson	(C.G. ENG)			4	5
4	4	C. J. Geier		2-5-90	H4-56	V. G. Johnson	for V.G. Johnson	2-5-90	H4-56	4	4
4	5	R. J. Landon	for R.J. Landon	2-7-90	H4-56	C. J. Koizumi		2/1/90	H4-56	4	5
4	4	M. R. Adams	for M.R. Adams	2-5-90	H4-56	J. R. Brodeur		2/1/90		4	5

18. Signature of EDT Originator — Date 10/6/89

19. Authorized Representative for Receiving Organization — Date

20. Cognizant/Project Engineer's Manager — Date 10/6/89

21. DOE APPROVAL (if required) Ltr No.
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- [ ] Disapproved w/comments

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SUPPORTING DOCUMENT			1. Total Pages 182
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7. Abstract

This document outlines a ground-water monitoring plan for the 216-S-10 Pond and Ditch located south of the 200 West Area on the Hanford Site in southeastern Washington State. During past operations, hazardous materials were discharged to the 216-S-10 Pond and Ditch. Installation of an interim-status ground-water monitoring system is required to determine the impacts of the facility on the quality of the water in the uppermost aquifer beneath the facility.

This document summarizes the available data on the 216-S-10 facility and vicinity and presents a plan to develop a ground-water monitoring network around the facility. The plan is to install five shallow monitoring wells, two upgradient and three downgradient of the facility, and one deep monitoring well downgradient of the facility. Three existing wells will be evaluated for their use in the planned monitoring network.

Airhart, S. P., J. V. Borghese, and S. Dudziak. 1990. Interim-Status Ground-Water Monitoring Plan for the 216-S-10 Pond and Ditch, WHC-SD-EN-AP-018, Rev. 0, prepared by Pacific Northwest Laboratory for Westinghouse Hanford Company, Richland, WA.

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WHC-SD-EN-AP-018 Rev. 0

INTERIM-STATUS GROUND-WATER MONITORING PLAN FOR THE 216-S-10 POND AND DITCH

S. P. Airhart
J. V. Borghese
S. Dudziak

January 1990

Prepared for Westinghouse Hanford Company
by the Pacific Northwest Laboratory
Richland, Washington 99352

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CONTENTS

FIGURES:

TABLES:

INTRODUCTION

This document presents a ground-water monitoring plan for the 216-S-10 Ditch and Pond (hereinafter called S-10 facility) located just south of the 200 West Area on the Hanford Site in southeastern Washington State (Figure 1.1). This ground-water monitoring plan, prepared by Pacific Northwest Laboratory for Westinghouse Hanford Company, is based on requirements for interim-status facilities, as defined by the Resource Conservation and Recovery Act (RCRA) of 1976 and amended by the Hazardous and Solid Waste Amendments of 1984. These regulations are promulgated by the U.S. Environmental Protection Agency (EPA) in 40 CFR Part 265, Subpart F, and by the Washington State Department of Ecology (Ecology) in WAC 173-303-400.

The S-10 facility receives wastewater from the 202-S Building in the 200 West Area. In the past, this wastewater contained known and suspected hazardous wastes. Since 1985, physical controls and operating procedures have been modified to prevent inadvertent discharge of chemicals to the wastewater stream. Because the S-10 facility is not expected to receive additional hazardous substances, the U.S. Department of Energy, Richland Operations (DOE-RL) has proposed that the S-10 facility be closed under RCRA interim status, although it will continue to receive wastewater not regulated under RCRA (DOE 1987).

PURPOSE AND OBJECTIVES

This plan presents a ground-water monitoring program for the S-10 facility. The program is designed to determine the impact of the S-10 facility on the quality of ground water in the uppermost aquifer beneath the facility [40 CFR 265.90(a)]. Specific objectives include

- describing an initial ground-water monitoring system that should indicate whether any hazardous constituents have migrated from the site to ground water
- describing an initial hydrogeologic characterization plan.

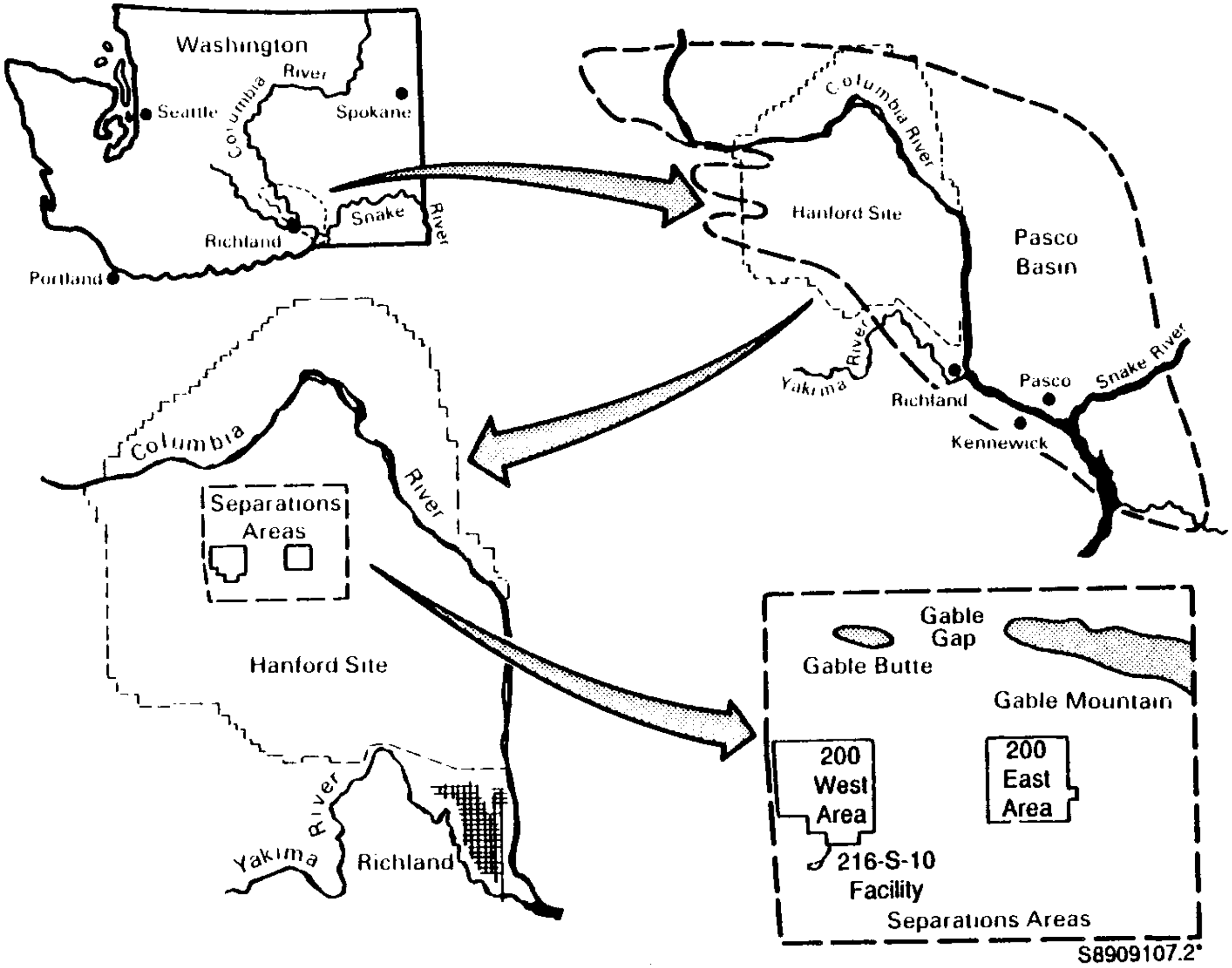

Figure 1.1. Map Showing the Locations of the Hanford Site and the Separations Areas.

Chapter 2.0 presents an overview and history of the S-10 facility, the waste characteristics of the discharges to the facility, and the geology and hydrogeology of the area. Chapter 3.0 describes the ground-water monitoring indicator-evaluation program, and an outline of a ground-water quality assessment program is presented in Chapter 4.0.

The hydrogeologic characterization activities and ground-water monitoring system presented in this plan constitute an initial program. Hydrogeologic data, ground-water chemistry data, and other information will be interpreted and evaluated before the initiation of any additional hydrogeologic characterization and well installation activities that might be deemed necessary.

BACKGROUND INFORMATION

The DOE's Hanford Site is used for nuclear reactor operation, reprocessing of spent fuel, and management of radioactive waste. The fuel reprocessing and radioactive waste management facilities in the 200-East and 200-West Areas (Separations Areas) are operated by Westinghouse Hanford.

FACILITY DESCRIPTION

The information contained in this section was primarily derived from three primary sources: Waste Information Data System (WIDS) General Summary Reports, Maxfield (1979), and DOE (1987). The WIDS data base is maintained and controlled by Westinghouse Hanford.

Location and Physical Description

The S-10 facility is located south-southwest of the 200-West Area, directly outside the perimeter fence (Figure 2.1). The ditch is approximately 4 ft wide at its base, 6 ft deep, and 2250 ft long. It is open and unlined. The ditch is now closed at the southern end and no longer conveys waste to the 216-S-10 Pond or other facilities. Figure 2.2 is a recent aerial photograph taken in the vicinity of the S-10 facility.

The 216-S-10 Pond covered 5 acres and included four finger-like leaching trenches when it was active. Like the ditch, the pond was unlined and therefore served as a percolation basin for liquid discharges.

As is evident from the site map (Figure 2.1), there are a number of waste disposal facilities in the vicinity of the S-10 facility. The WIDS General Summary Reports for the 216-S-5 Crib, 216-S-6 Crib, 216-S-11 Pond, 216-S-17 Pond, 216-S-16 Pond and Ditches, and 216-U-10 Pond are provided in Appendix A. These summary reports give general facility descriptions, including descriptions of the site and the waste it received. It is important to note that effects from these sites on ground-water chemistry may in turn influence the ground-water chemistry near the S-10 facility.

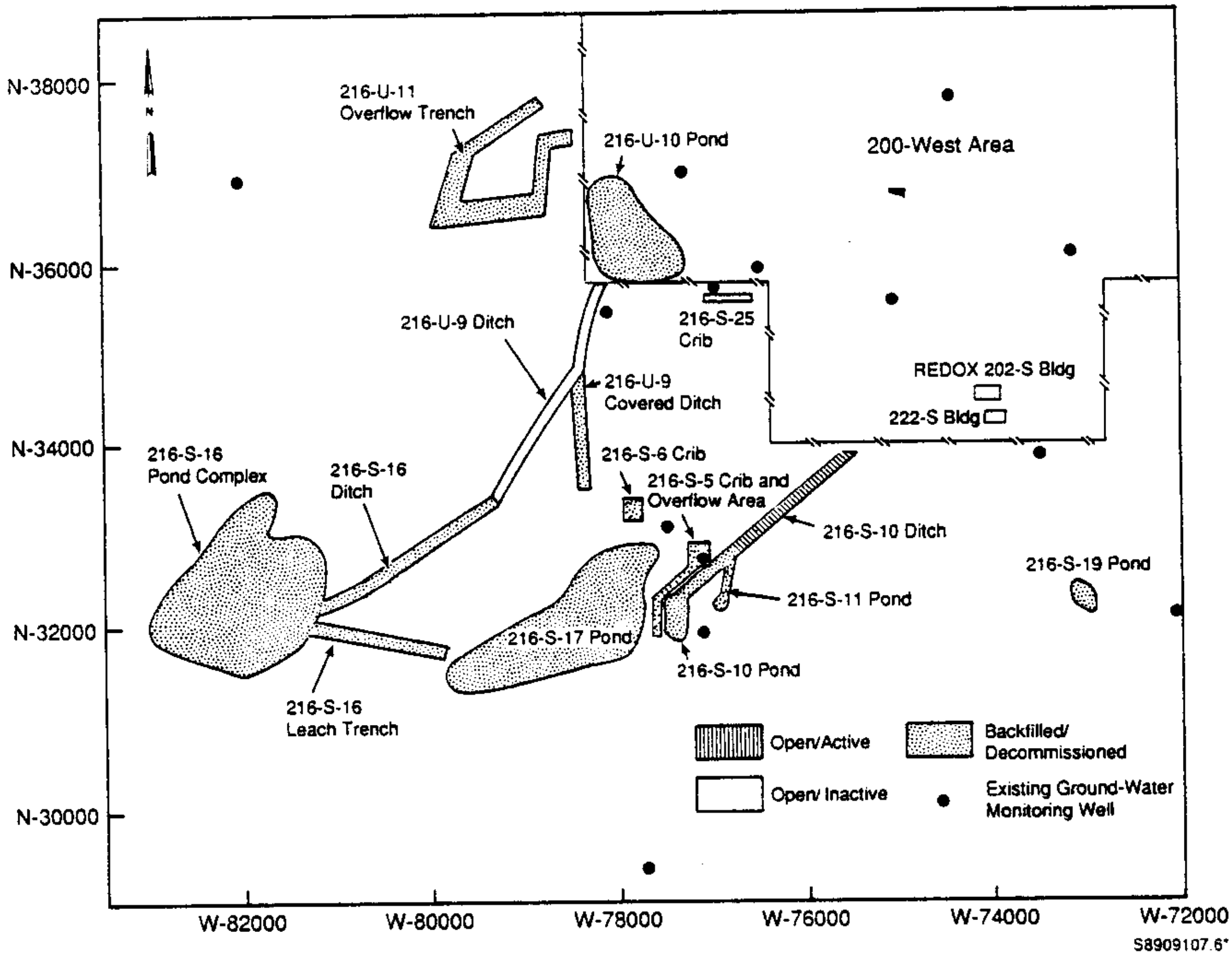

Figure 2.1. S-10 Facility Site Map.

History of Operations

In August 1951, the 216-S-10 Ditch began receiving wastewater from the Reduction-Oxidation (REDOX) Plant (202-S Building) chemical sewer (Figure 2.1). In February 1954, the 216-S-10 Pond was dug at the southwest end of the ditch to provide more surface area for percolation. In May 1954, increased discharges to the S-10 facility necessitated the digging of the two 216-S-11 Leach Ponds on the southeast side of the 216-S-10 Ditch. The 216-S-11 lobes were dammed in 1965, so that all of the effluent was diverted to the 216-S-10 Pond. The REDOX plant was placed on stand-by in 1967 and retired in 1969. At this time, effluent to the S-10 facility was reduced

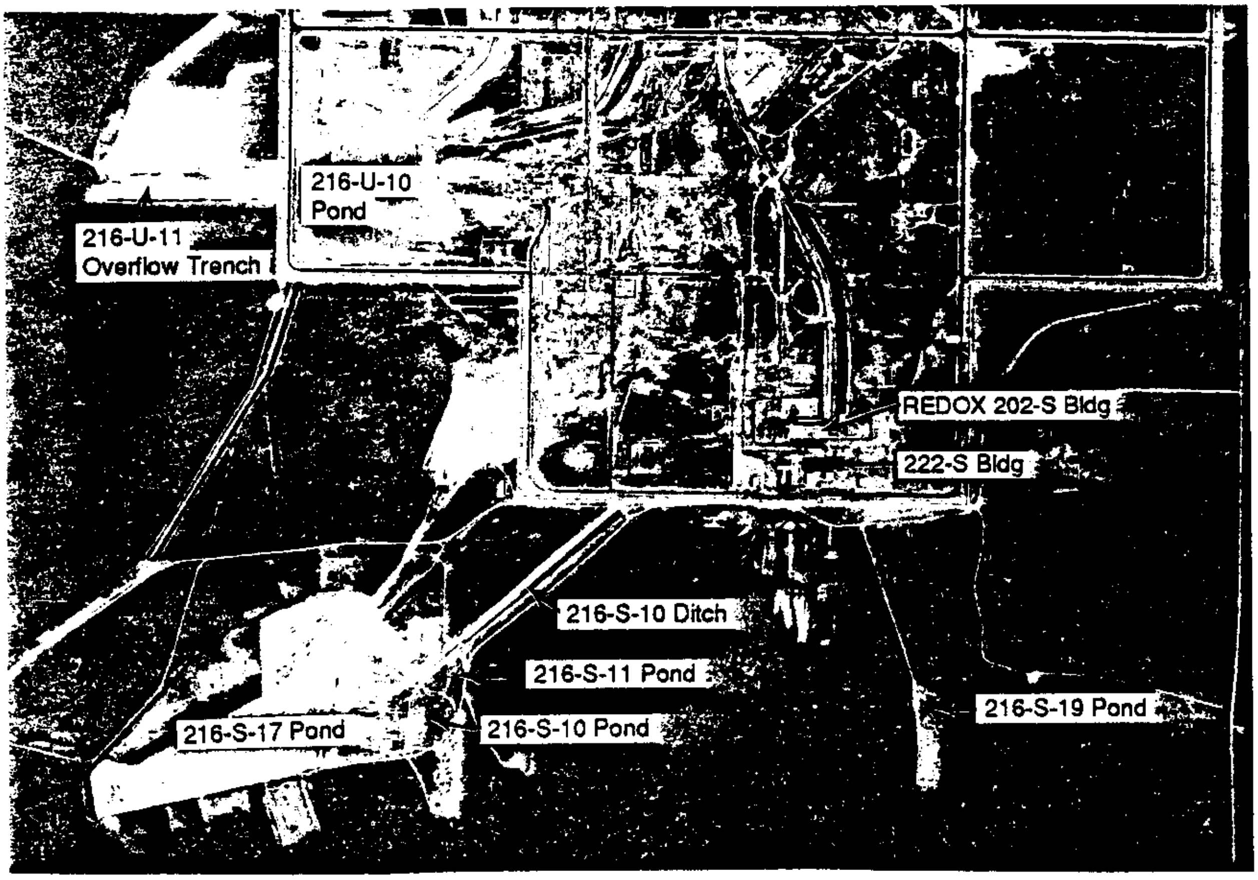

Figure 2.2. Aerial Photograph of the S-10 Facility and Vicinity.

primarily to chemical sewer waste. When the REDOX plant was deactivated in 1972, physical controls were administered to eliminate hazardous discharges from the 202-S Building to the S-10 facility. These controls reduced discharges from the 202-S Building to nonhazardous chemical sewer effluent.

In September 1983, the S-10 facility received a hazardous waste discharge from the Chemical Engineering Laboratory (222-S Building). This laboratory was a pilot plant that produced synthetic double-shell-tank slurry to be used in testing methods to recover slurry from double-shell tanks (DOE 1987). The characteristics of the discharge from this facility are described in more detail in the following section.

The 216-S-10 Pond and portions of the 216-S-10 Ditch were decommissioned, backfilled, and stabilized in October 1985. Currently, the remaining portion of the 216-S-10 Ditch receives nonhazardous (i.e., not regulated under RCRA) chemical sewer waste from the 202-S Building.

Waste Characteristics

This section summarizes the chemical and physical characteristics of past and present discharges to the S-10 facility.

As mentioned in the previous section, most of the liquid waste discharged to the S-10 facility came from the REDOX Plant's chemical sewer. This waste stream was composed of cooling water, steam condensate, water tower overflow, and drain effluent. Releases of hazardous constituents to the S-10 facility from 1951 to 1966 are poorly documented. An unspecified quantity of aluminum nitrate was discharged to the 216-S-10 Ditch in 1954 (Maxfield 1979). In addition, it has been recorded that there was a problem of radioactivity in the ditch from contaminated floor and sewer drains within the REDOX Plant (Maxfield 1979). However, these problems are poorly documented.

In September 1983, a documented hazardous-waste discharge to the S-10 facility occurred (DOE 1987). In this incident, 110 gal (or 1560 lb) of a synthetic double-shell-tank slurry was discharged to the S-10 facility. The waste consisted largely of $NaNO_3$ and NaOH, with small quantities of Na_3PO_4, NaF, NaCl, and $K_2Cr_2O_7$. Samples of this slurry taken from the two feed tanks, TK-505 and TK-509, before the discharge occurred were analyzed, and the results of these analyses are presented in Table 2.1.

The portion of the 216-S-10 Ditch that is still in service receives chemical sewer discharge from the 202-S Building. The waste stream enters the ditch through a 12-in.-dia vitrified clay pipe. This waste stream is composed of cooling water from water-scrubbed air-conditioning filters, air-conditioning bearings, and seal loops; overflow from the sanitary-water tower; steam condensate from building heaters and station steam supply; and floor-drain effluent produced by pipe leaks and pump overflow (DOE 1987). As part of deactivation of the REDOX Plant in 1972, the source streams from the 202-S Building were routed so that they would not come into contact with hazardous materials. The annual volume of effluent currently discharged to the 216-S-10 Ditch is approximately 5.0×10^7 gal (DOE 1987). Coony and

Table 2.1. Composition of Synthetic Double-Shell-Tank Slurry.

Component	Concentration (molarity) TK-505	TK-509
Al	1.225	1.235
OH	3.40	3.42
NO_2	2.18	2.115
NO_3	2.54	2.50
CO_3	0.159	0.157
PO_4	0.041	0.027
SO_4	<0.052	<0.052
F	0.062	0.05
Cl	0.115	0.103
Cr_2O_7	0.106	0.0983

Thomas (1989, p. D-4) have reported a cumulative liquid discharge of 1.09×10^9 gal to the S-10 facility. The discharge water is sampled periodically for chemical analysis. Results from the samplings performed in 1986 and 1987 are presented in Table 2.2. None of the constituents analyzed for in these samplings (Table 2.2) exceed EPA's Interim Primary Drinking Water Parameters.

GEOLOGY

This section provides background information on the geology of the Hanford Site, the Separations Areas, and the S-10 facility site to support the preparation of the indicator-evaluation ground-water monitoring program presented in Chapter 3.0. The geology of the Columbia Plateau, and particularly of the Pasco Basin, has been studied in detail as a part of DOE's siting studies for a deep geologic repository for nuclear waste. The Consultation Draft, Site Characterization Plan (DOE 1988) summarizes much of the information known about the Hanford Site, especially the 200-West Area, near which the candidate repository site was located. Studies have also been conducted in support of licensing nuclear power plants, including those for the Washington Public Power Supply System (Supply System 1981) and for Puget

Table 2.2. Analyses from the 202-S Building Discharge to 216-S-10 Ditch (Jungfleisch 1988).

Constituent[a]	Sampling Date 06/26/86	08/19/86	10/13/86	02/17/87
Aluminum	<1.5E+02	<1.5E+02	<1.5E+02	<1.5E+02
Ammonium	<5.0E+01	<5.0E+01	<5.0E+01	No data
Antimony	<1.0E+02	<1.0E+02	<1.0E+02	<1.0E+02
Barium	2.6E+01	3.0E+01	2.3E+01	2.8E+01
Beryllium	<5.0E+00	<5.0E+00	<5.0E+00	<5.0E+00
Cadmium	<2.0E+00	<2.0E+00	<2.0E+00	<2.0E+00
Calcium	1.7E+04	No data	No data	2.1E+04
Chromium	<1.0E+01	<1.0E+01	<1.0E+01	<1.0E+01
Copper	<1.0E+01	<1.0E+01	<1.0E+01	<1.0E+01
Iron	<5.0E+01	<5.0E+01	<5.0E+01	<5.0E+01
Lead	No data	No data	<5.0E+00	<5.0E+00
Magnesium	3.9E+03	3.8E+03	3.8E+03	4.6E+03
Manganese	<5.0E+00	8.0E+00	8.0E+00	<5.0E+00
Mercury	<1.0E-01	No data	<1.0E-01	<1.0E-01
Nickel	<1.0E+01	<1.0E+01	<1.0E+01	<1.0E+01
Potassium	7.3E+02	7.3E+02	7.7E+02	7.7E+02
Silver	<1.02E+01	<1.0E+01	<1.0E+01	<1.0E+01
Sodium	2.2E+03	2.4E+03	2.0E+03	2.0E+03
Strontium	<3.0E+02	<3.0E+02	<3.0E+02	<3.0E+02
Uranium	1.4E+00	5.0E-01	1.0E+00	4.5E-01
Vanadium	<5.0E+00	<5.0E+00	<5.0E+00	<5.0E+00
Zinc	9.0E+00	7.0E+00	<5.0E+00	<5.0E+00
Chloride	7.6E+02	1.2E+03	8.8E+02	1.1E+03
Cyanide	<1.0E+01	<1.0E+01	<1.0E+01	<1.0E+01
Fluoride	<5.0E+02	<5.0E+02	<5.0E+02	<5.0E+02
Nitrate	1.1E+03	2.9E+03	<5.0E+02	<5.0E+02
Phosphate	<1.0E+03	<1.0E+03	<1.0E+03	<1.0E+03
Sulfide	<1.0E+03	No data	No data	<1.0E+03
Sulfate	9.8E+03	9.4E+03	9.7E+03	1.4E+04
Chloroform	<1.0E+01	<1.0E+01	<1.0E+01	<1.0E+01
Amount (L/month)	1.7E+07	1.7E+07	1.7E+07	1.7E+07
pH (dimensionless)	6.40	6.84	5.4	5.45
Temperature (degrees Celsius)	No data	24.7	20.1	8.4
Alpha Activity (pCi/L)	<4.0E+00	9.2E-01	-1.3E-01	1.1E+00
Beta Activity (pCi/L)	3.6E+00	2.9E+00	3.9E+00	8.3E+00
Conductivity (μS/cm)	1.2E+02	1.4E+02	1.3E+02	1.3E+02
Total Organic Carbon	1.9E+03	1.6E+03	1.3E+03	1.2E+03
Total Organic Halide	2.2E+01	<2.1E+01	1.0E+02	8.7E+01

(a) Unless otherwise noted, analyte concentrations are in ppb.

Sound Power and Light's Skagit/Hanford Project (PSPL 1982). More detailed information is available in the following reports:

- structural geology and tectonics - Caggiano and Duncan (1983) and Reidel et al. (1982)
- basalt stratigraphy and chemistry - Swanson et al. (1979) and Reidel et al. (1982)
- sedimentary units interfingered with and overlying the basalts - Bjornstad (1984, 1985); Fecht et al. (1985); Myers/Price et al. (1979); Myers and Price (1981); and Graham et al. (1984). Tallman et al. (1979) is the only in-depth study of the geology of the Separations Areas.

Regional Geologic Setting

The Hanford Site lies within the Columbia Plateau, which is generally characterized by a thick sequence of tholeiitic basalt flows called the Columbia River Basalt Group (Swanson et al. 1979). These flows have been folded and faulted, creating broad structural and topographic basins separated by asymmetric anticlinal structures (i.e., ridges). The Hanford Site lies within one of these basins, the Pasco Basin (Figure 2.3).

Principal geologic units within the Pasco Basin include, in ascending order, the Columbia River Basalt Group (Miocene), the Ringold Formation (Miocene-Pliocene), and the Hanford formation (Pleistocene). A regionally discontinuous veneer of recent alluvium, colluvium, and/or eolian sediments overlies the principal geologic units.

Geology of the Separations Areas

The topography of the Separations Areas is primarily the result of two geomorphic processes: 1) Pleistocene cataclysmic flooding, and 2) Holocene eolian activity. Cataclysmic flooding, which ended about 13,000 years ago (Mullineaux et al. 1978), created Cold Creek bar (Bretz et al. 1956), a prominent flood feature within the Separations Areas (Figure 2.4). The last cataclysmic flood(s) covered the Separations Areas with a blanket of coarse-grained deposits, which become finer-grained to the south. The northern boundary of the Cold Creek bar is defined by an erosional channel running

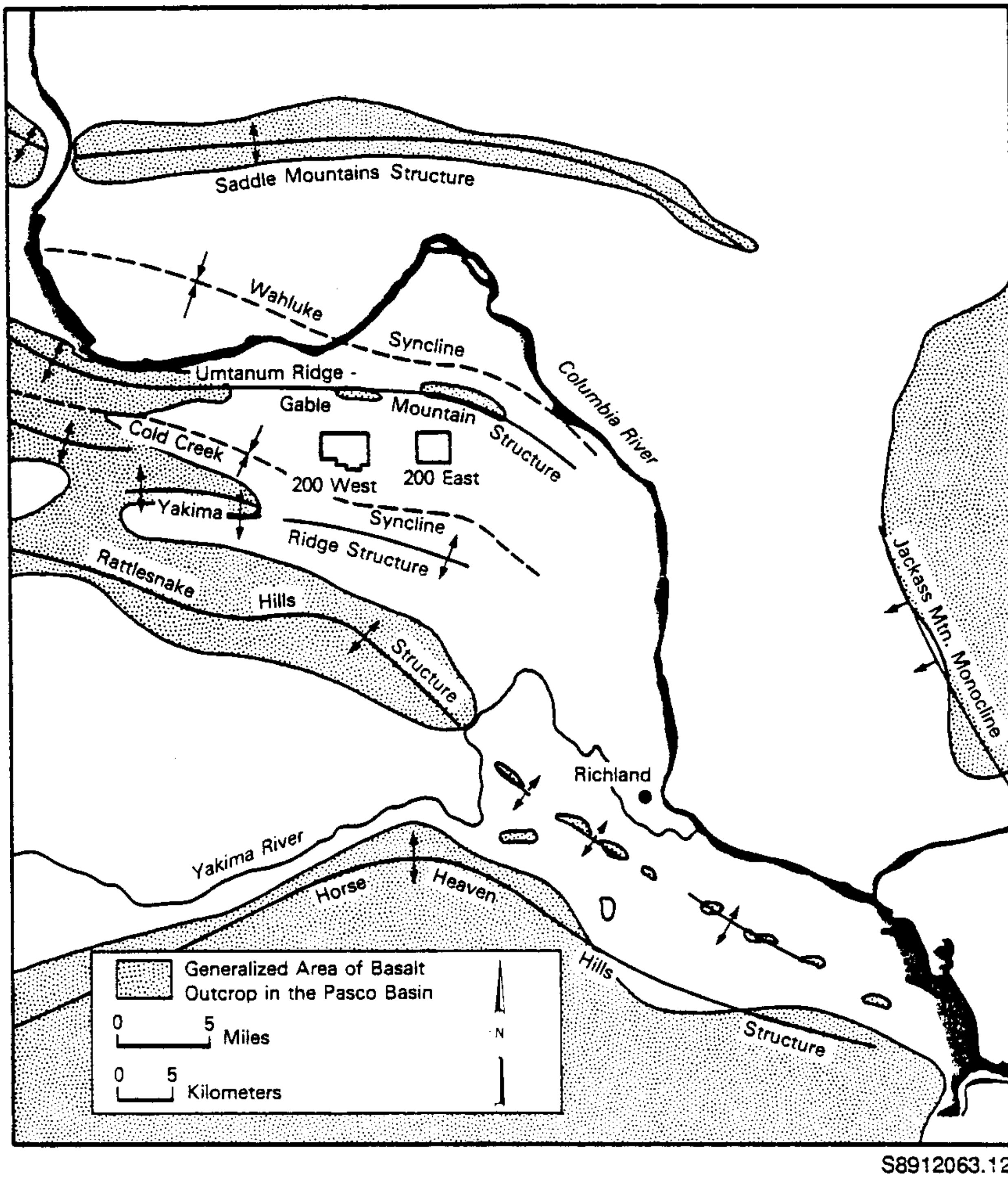

Figure 2.3. Location Map of the Hanford Site Within the Pasco Basin Showing Major Structures Within the Basin.

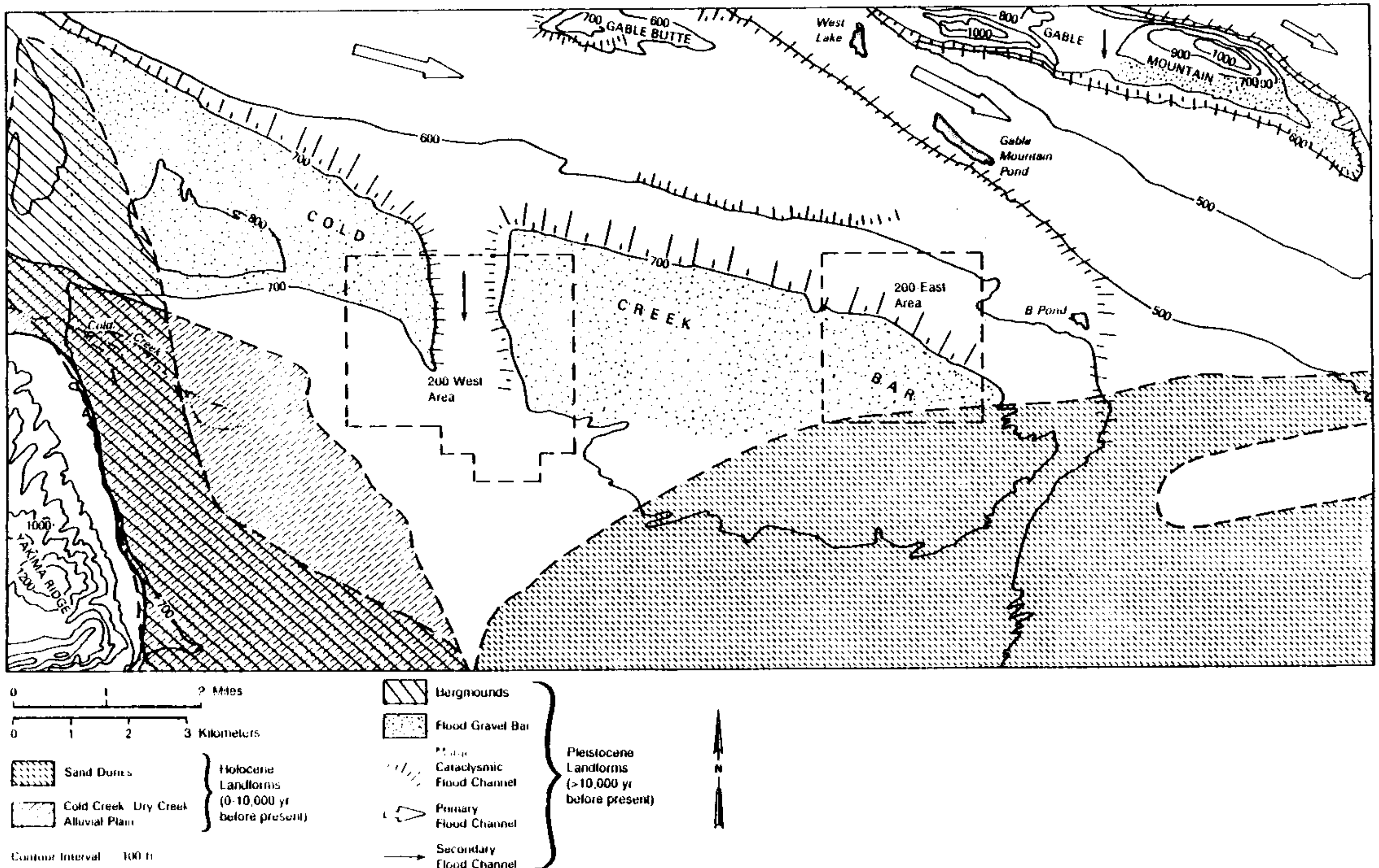

Figure 2.4. Geomorphic Features Surrounding the Separations Areas.

east-southeast, which formed during waning stages of flooding as floodwaters drained from the basin (Bjornstad et al. 1987).

Since the end of the Pleistocene, winds have reworked the surface of the glaciofluvial sediments locally, depositing a thin veneer of eolian sand in places. Holocene sand dunes are present along the southern boundary of the 200-East Area (Figure 2.4). Holocene alluvium, associated with the Cold Creek-Dry Creek alluvial plain, was deposited less than 1 mi southwest of the 200-West Area (Figure 2.4).

Structurally, the Separations Areas lie within the Cold Creek syncline, which is bounded on the north by the Umtanum Ridge-Gable Mountain anticlinal structure and on the south by the Yakima Ridge anticlinal structure (Figure 2.3). In the Separations Areas, the top of basalt generally dips gently (less than 5 degrees) to the south-southwest, except in the southwest corner of the 200-West Area, where beds are nearly horizontal along the axis of the Cold Creek syncline.

The generalized stratigraphy of the Separations Areas is shown in Figure 2.5. Bedrock is composed of basalt flows and sedimentary interbeds, which belong to the Columbia River Basalt Group and Ellensburg Formation, respectively. Overlying Columbia River basalt is the fluvial-lacustrine Ringold Formation consisting of variably mixed and interbedded layers of gravel, sand, and mud (i.e., silt and clay). The thickness of the Ringold Formation ranges from 0 ft in the northern part of the 200-East Area to about 500 ft in the southwest portion of the 200-West Area near the axis of the Cold Creek syncline (DOE 1988; Tallman et al. 1979).

The Ringold Formation has locally been subdivided into four stratigraphic units: basal, lower, middle, and upper. The basal Ringold unit consists of silty-sandy gravel overlain by a fining upward sequence of sand and mud. Overlying the basal Ringold is the lower Ringold unit, another fine-grained unit consisting of mostly mud. Sediments of the lower Ringold and upper basal Ringold units have been recognized locally as a potential confining layer.

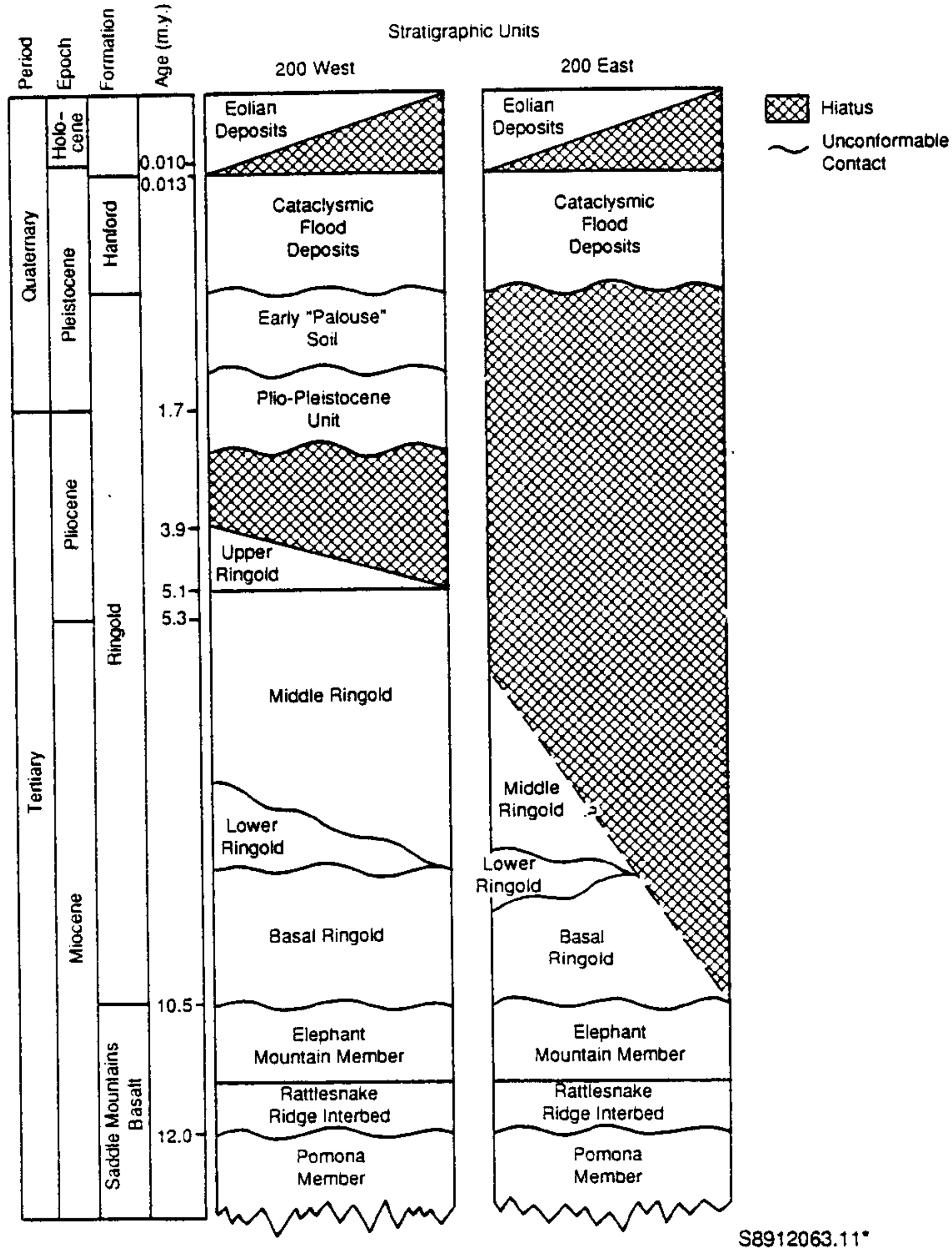

Figure 2.5. Generalized Geologic Columns for the Separations Areas.

The middle Ringold is by far the thickest of the Ringold units in the vicinity of the Separations Areas. Its predominant texture consists of well-rounded sandy gravel with some sand and silty-sand lenses. The gravels typically range from pebble to cobble in size; however, boulders are locally common (Tallman et al. 1979). Because of their textures and the similarity of their gravel lithologies, the coarse-grained basal and middle Ringold units are difficult to distinguish unless separated by the fine-grained sediments of the upper basal Ringold unit or the lower Ringold unit. The uppermost unit, the upper Ringold, is another sequence of thinly bedded, well-sorted sand and/or mud (DOE 1988; Tallman et al. 1979).

Not all of the units of the Ringold Formation are present throughout the Separations Areas. Erosion by the ancestral Columbia River and later cataclysmic flooding during the Pleistocene Epoch have removed some or all of the Ringold Formation in some areas (DOE 1988; Tallman et al. 1979). All four units are currently identified only in the western and southern portion of the 200-West Area, while little or no Ringold formation is present in the northeastern part of the 200-East Area (Last et al. 1989; Tallman et al. 1979).

A well-developed calcrete belonging to the Plio-Pleistocene unit is found on the uppermost surface of the eroded Ringold sediments in the 200-West Area (Bjornstad 1984; Last et al. 1989). In places, the Plio-Pleistocene unit is overlain by as much as 30 ft of an eolian deposit of fine-grained sand and silt referred to as the early "Palouse" soil. Both of these units are present over most of the 200-West Area, but they have apparently been eroded from beneath the 200-East Area.

The cataclysmic flooding that eroded the Ringold Formation also deposited a sequence of relatively unconsolidated mud, sand, and gravel informally called the Hanford formation. At least four major flood events occurred in the Pasco Basin during the Pleistocene (Fecht et al. 1985). Near flood channels (e.g., in the northern 200-East Area), the Hanford formation consists of dominantly coarse gravel and sand (Pasco Gravels facies), while to the south and west, transitional-type deposits (between main channel and slack-water deposits) of sand and silt lie between or beneath coarse-grained flood deposits (Last et al. 1989). Within much of the southern portion of the Separations Areas, the Hanford formation consists predominantly of sand. Thickness of the formation ranges from approximately 70 ft in part of the 200-West Area to a maximum of about 350 ft east of the 200-East Area (Tallman et al. 1979).

The contact between the Hanford and Ringold Formations is commonly a transition upward from more indurated deposits containing a variety of lithologies (Ringold Formation) to very weakly cemented or unconsolidated sediments with a higher proportion of basaltic clasts (Hanford formation). The textures of the Pasco Gravels and the middle Ringold are similar, although the difference in gravel lithologies can sometimes be used to distinguish between the two. However, in some places, basalt-rich gravel layers have been found in the middle Ringold unit, and if the middle Ringold unit and Pasco Gravels are not separated by the upper Ringold, the Plio-Pleistocene unit, and/or the early "Palouse" soil, they can be difficult to distinguish. This is particularly true where considerable reworking and incorporation of the Ringold sediments into the Hanford formation has occurred.

Graham et al. (1984) indicate the possibility that the Elephant Mountain Member, which acts as a confining layer between the unconfined aquifer and the Rattlesnake Ridge aquifer, has been completely eroded near the northeast corner of the 200-East Area. Partial erosion may occur over a larger area. As a result, the Hanford formation may directly overlie the Rattlesnake Ridge interbed northeast of the 200-East Area, permitting intercommunication between the two aquifers (see Hydrogeology section).

Geology Beneath the S-10 Facility

The S-10 facility lies at an elevation of about 650 ft above mean sea level (MSL). The land surface in the vicinity of the S-10 facility slopes roughly 3 ft/1000 ft to the southwest.

An interpretation of the subsurface geology near the facility is based on an evaluation of drill logs and sieve data from nearby wells, and from previous investigations by Bjornstad (1984), DOE (1988), and Last et al. (1989). Drill logs and sieve data from eight wells (Appendix B) located in the vicinity of the S-10 facility were used to develop the cross sections in Figures 2.6 and 2.7. These cross sections illustrate the stratigraphy in the vicinity of the S-10 facility. Figure 2.8 shows the locations of these cross sections. The correlations presented in Figures 2.6 and 2.7 are based primarily on information from Bjornstad (1984).

The depth to basalt beneath the S-10 facility is approximately 570 to 590 ft. The first basalt surface encountered at depth is the Elephant Mountain Member (Bjornstad 1984). Basalt beneath the site dips to the southwest with a gradient of approximately 6 ft/1000 ft in the direction of the axis of the Cold Creek syncline. A discontinuous mud layer overlies the basalt in the vicinity of the S-10 facility. This probably is a result of weathering and alteration of the upper basalt surface before deposition of the overlying sediments.

A sandy gravel to gravelly sand unit approximately 80 to 100 ft thick directly overlies the basalt. This unit consists primarily of a gravel to sandy gravel to the north and grades to a sand to gravelly sand south of the facility. This unit corresponds to the coarse-grained facies of the basal Ringold unit as defined by Bjornstad (1984). Directly overlying this unit is a thick sequence of mud to muddy sand. This unit is approximately 50 ft thick beneath the S-10 facility. Because this unit appears to be continuous beneath the facility, it is assumed to represent the bottom of the uppermost aquifer. The stratigraphic cross-sections (Figures 2.6 and 2.7) combine this mud to muddy sand into one textural unit; however, Bjornstad (1984) separates it into the fine-grained facies of the basal Ringold and the lower Ringold unit, with the former being defined by a calcium-carbonate-rich paleosol developed along its upper surface.

Directly overlying the mud to muddy sand unit is a sequence of gravel to sandy gravel with minor sand lenses. This unit is thickest (approximately 260 ft thick) north of the S-10 facility beneath well 699-35-78A, and it thins generally to the south and east, where it contains numerous sandy lenses. Bjornstad (1984) has identified this coarse-grained sequence as the middle Ringold unit (Figure 2.5).

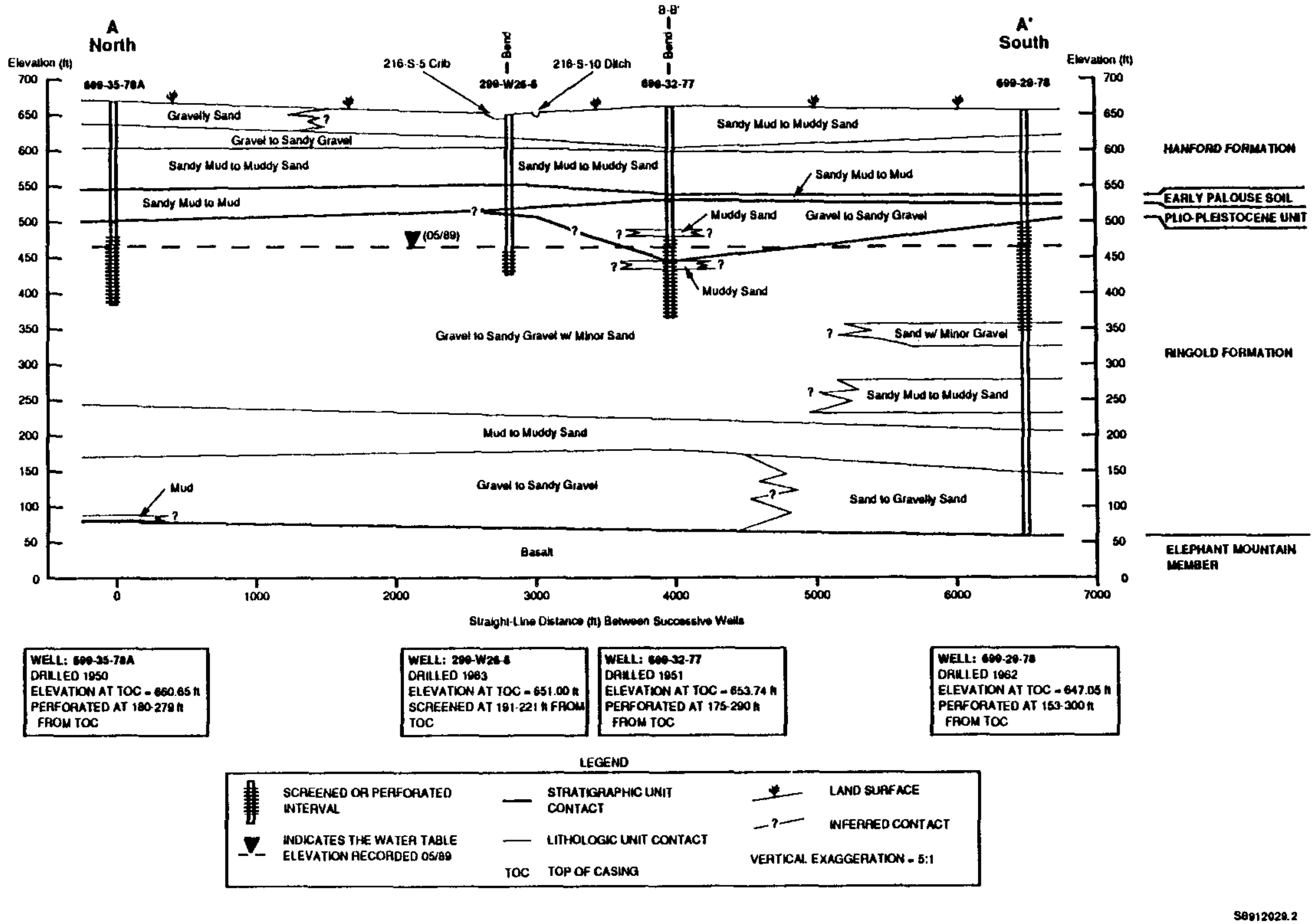

Figure 2.6. Stratigraphic Cross Section A-A'.

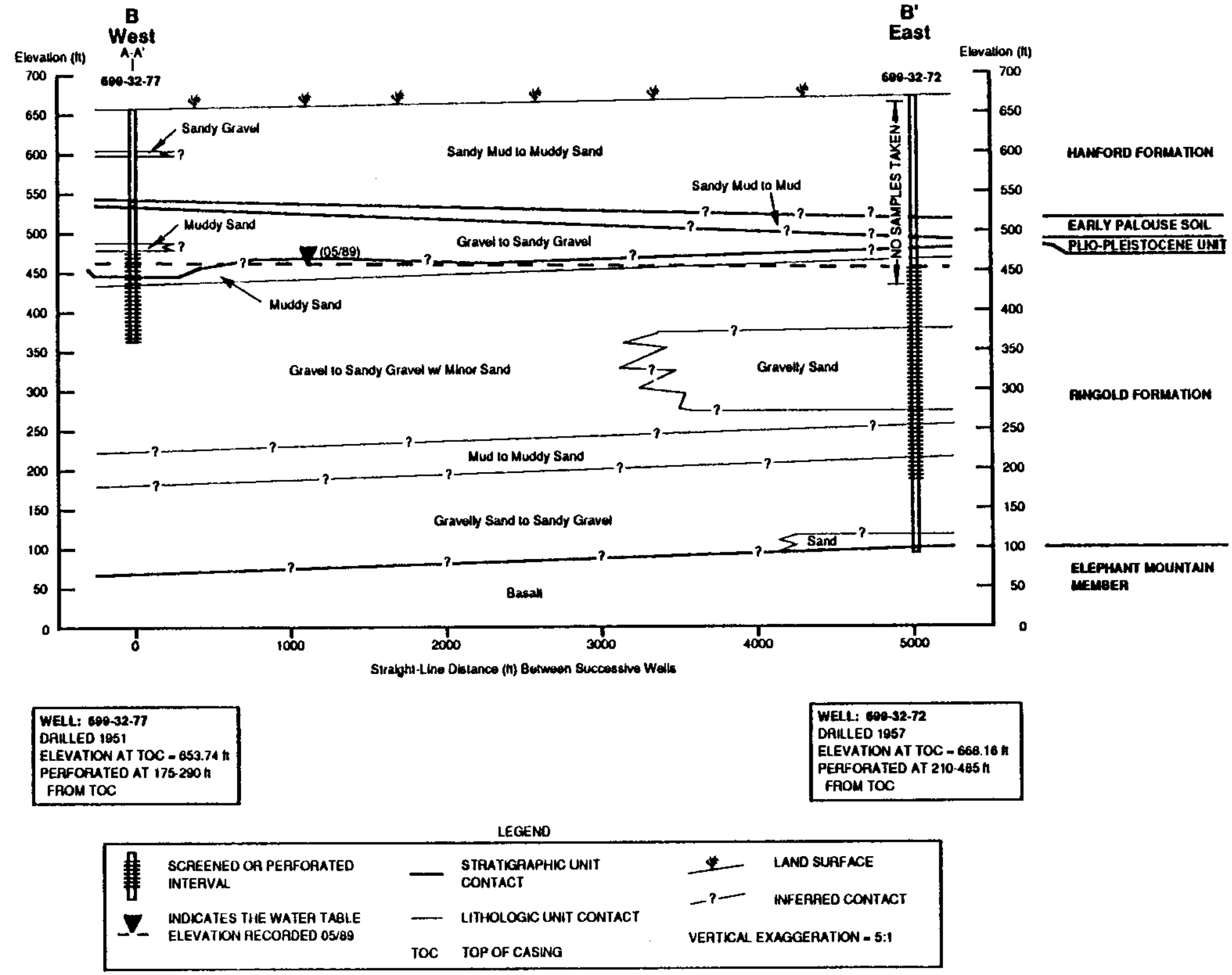

Figure 2.7. Stratigraphic Cross Section B-B'.

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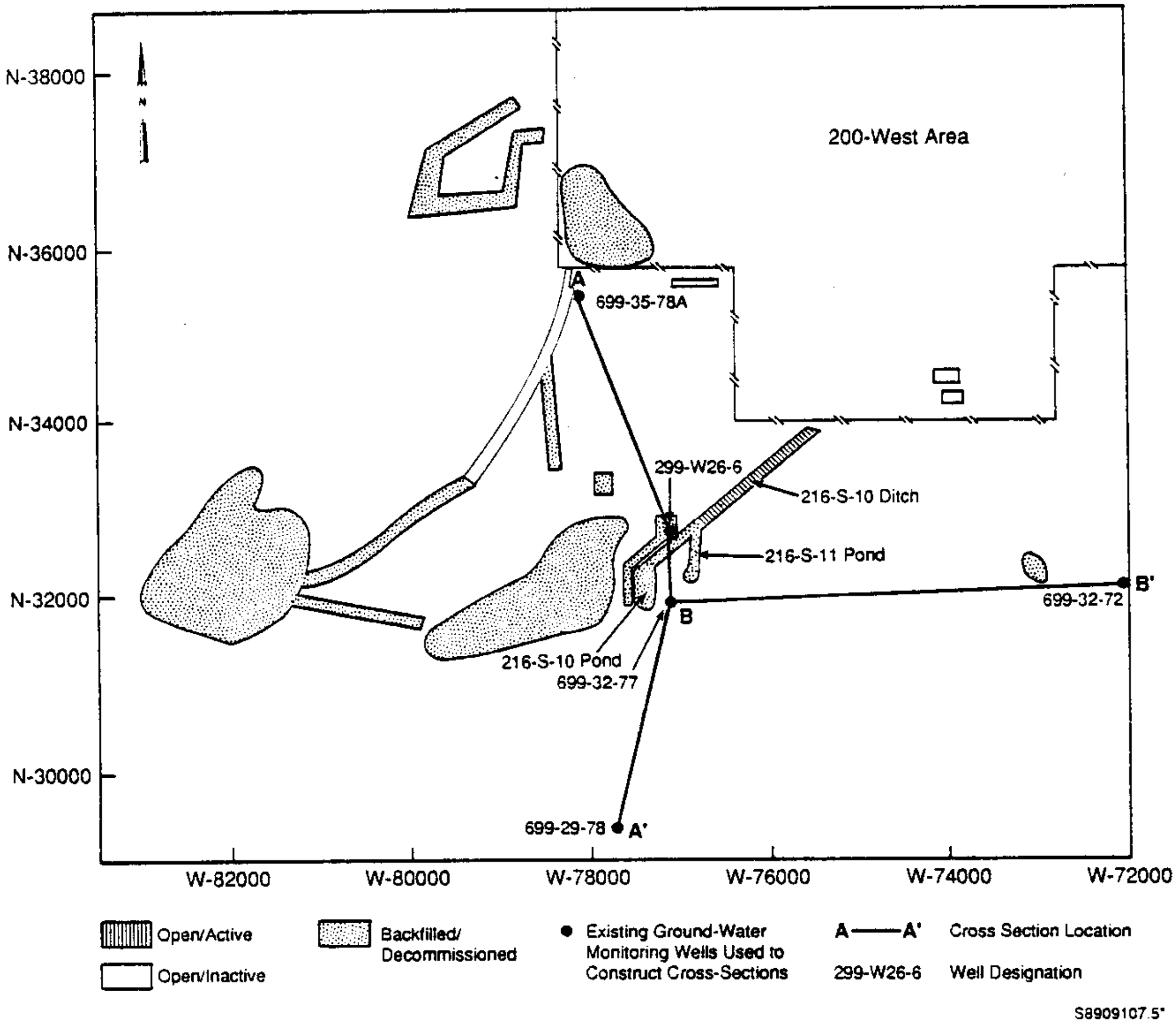

Figure 2.8. Stratigraphic Cross-Section Locations in Vicinity of 216-S-10 Ditch and Pond.

The water table lies within the middle Ringold unit, except beneath well 699-32-77, where an especially thick sequence of the coarse-grained facies of the Plio-Pleistocene unit is present. This coarse-grained facies represents a channel-fill deposit consisting of up to 80 ft of gravel to sandy gravel (Figure 2.6). This facies thins to approximately 20 ft thick to the south at well 699-29-78 and to the east at well 699-32-72, and it pinches out to the north beyond well 299-W26-6 (Figures 2.6 and 2.7). This coarse-grained facies represents the sidestream-alluvial facies of the Plio-Pleistocene unit and can be distinguished from the underlying Ringold Formation by a higher concentration of calcium-carbonate cement, angular clasts, and a higher percentage of basalt (DOE 1988). Directly overlying the Plio-Pleistocene unit is a 10- to 15-ft-thick unit of loose, calcareous, sandy mud to mud. Tallman et al. (1979) refer to these fine-grained eolian deposits as the early "Palouse" soil (see Figure 2.5).

The uppermost unit beneath the S-10 facility is referred to as the Hanford formation and locally consists of approximately 100 ft of slack-water flood deposits consisting of sandy mud to muddy sand. To the north, this unit contains more lenses of gravel to sandy gravel, especially toward the top of the sequence (see Figure 2.6).

Most of the surficial deposits in the vicinity of the S-10 facility have been reworked by construction activities related to the decommissioning, backfilling, and stabilization of the various waste sites in the area.

HYDROGEOLOGY

This section provides background information on the hydrogeology of the Hanford Site, the Separations Areas, and the S-10 facility to support the preparation of the indicator-evaluation ground-water monitoring program presented in Chapter 3.0. Detailed descriptions of the hydrogeology of the Hanford Site and the Separations Areas are available in reports by DOE (1988), Gephart et al. (1979), Graham et al. (1981, 1984), Last et al. (1989), and Law et al. (1987), and in water-level data collected and reported semiannually (Kasza and Schatz 1989).

Regional Hydrogeologic Setting

The Hanford Site lies within a semiarid climatic zone that commonly has warm, dry summers and cool winters. Climatic records indicate that annual precipitation at the Hanford Site has varied from a low of 3 in. to a high of 11.5 in. and has a mean of 6.3 in. (DOE 1988). The largest percentage of annual precipitation, 42%, occurs between November and February. The largest surface water body at Hanford is the Columbia River (see Figure 1.1), which serves as the local and regional discharge for ground-water and surface-water runoff.

Some evapotranspiration studies have been conducted on the Hanford Site, but no detailed study has been conducted for the Separations Areas specifically. Wallace (1977) used Hanford Meteorology Station data to compute average potential evapotranspiration for the Hanford Site using three different methods: the Penman, Thornthwaite-Maither, and Morton methods. Estimates for potential evapotranspiration values range from five to nine times the mean annual precipitation. However, a comparison of monthly estimates reported by Stone et al. (1983) indicates that, for the months of November through February, precipitation may exceed potential evapotranspiration and may be available for ground-water recharge.

Within the Hanford Site, natural recharge rates have been estimated to range from near zero to more than 4 in. annually, depending on surface conditions (Gee 1987; Routson et al. 1988). Recharge rates are low where fine-textured sediments and deep-rooted plants occur (e.g., in undisturbed portions of the 200 Areas). The larger values are associated with areas having a coarse, gravelly surface and no vegetative cover.

Ground water beneath the Hanford Site occurs under unconfined, semiconfined, and confined conditions. The unconfined aquifer is contained primarily within the lower portion of the Hanford formation and the middle unit of the Ringold Formation (Graham et al. 1981). The base of the unconfined aquifer is either the basalt surface or, where they are present, the clays and silts of the lower and basal Ringold units (see Figure 2.3). Where these fine-grained sediments occur, they represent a semiconfining layer for the coarse-grained facies of the basal Ringold unit (DOE 1988). Confined aquifers beneath the Hanford Site include sedimentary interbeds and interflow zones that occur between dense basalt flows of the Columbia River Basalt Group.

The major sources of natural recharge to the unconfined aquifer are rainfall and runoff from areas of high relief bordering the Hanford Site, ephemeral streams in the Cold Creek and Dry Creek valleys, and localized areas where river water is induced into the ground water as temporary bank storage during high stages of the Yakima or Columbia rivers (Graham et al. 1981). Discharge from the unconfined aquifer is primarily to the Columbia River.

Hydrogeology of the Separations Areas

As more characterization efforts are undertaken on the Hanford Site, understanding of the geologic framework and its relation to the hydrogeologic system will continue to be developed and refined. This document does not attempt to integrate all that is known of the hydrogeologic system within the Separations Areas. Instead, this discussion is limited to the hydrologic properties of the uppermost portion of the unconfined aquifer contained in the Hanford and Ringold formations.

The unconfined aquifer receives artificial recharge from liquid-waste disposal areas. This artificial recharge is estimated to be 10 times greater than natural recharge (Graham et al. 1981). Graham et al. (1981) estimated natural recharge from the Cold Creek valley to the Separations Areas to be approximately 1.3×10^6 gal/d. The total volume of liquid effluent discharged to radioactive disposal facilities in the Separations Areas in 1988 was approximately 2.4×10^{10} gal (Coony and Thomas 1989, p. 3-3), corresponding to a rate of approximately 6.6×10^7 gal/d.

The major sources of artificial recharge in the central Hanford Site have been three waste ponds (216-U-10 Pond, Gable Mountain Pond, and 216-B-3 Pond). All are located in or near the Separations Areas. These areas of artificial recharge have had, and continue to have, a major effect on the ground-water flow within the unconfined aquifer. 216-U-10 Pond, located in the 200-West Area, and Gable Mountain Pond, located north of the 200-East Area, were deactivated in 1984 and 1987, respectively. 216-B-3 Pond is scheduled for decommissioning in the mid-1990s.

The depth to water within the unconfined aquifer in the Separations Areas ranges from approximately 190 ft beneath 216-U-10 Pond to approximately 340 ft west of the 200-East Area. The saturated thickness of the unconfined aquifer ranges from 0 ft at the north edge of the 200-East Area to more than 250 ft in the northwest part of the 200-West Area.

Ground-water elevation contours for January 1989 for the unconfined aquifer in the Separations Areas are shown in Figure 2.9 (Kasza and Schatz 1989). The regional flow in the Separations Areas is generally from west to east, but it is affected by two ground-water mounds that have resulted from discharges to 216-U-10 Pond and 216-B-3 Pond. Ground-water flow beneath the 200-West Area is generally toward the north and the east, away from the mound created by past discharges to 216-U-10 Pond. As this mound dissipates, the horizontal hydraulic gradient is expected to decrease and shift to the east. The horizontal hydraulic gradient in the 200-West Area is currently relatively large, ranging from 1.5 ft/1000 ft to 4 ft/1000 ft. Downward vertical hydraulic gradients are expected to be present within the unconfined aquifer in portions of the 200-West Area as a result of the 216-U-10 Pond ground-water mound (Graham et al. 1981).

A comparison between the hindcast water-table map of the Hanford Site for 1944 (Figure 2.10) and the Separations Areas water-table map for January 1989 (Figure 2.9) indicates that the natural water-table elevation in the 200-West Area has risen 65 ft since 1944. The hindcast map indicates that in 1944 the direction of regional flow was toward the east, and the natural hydraulic gradient was on the order of 1 ft/1000 ft in the 200-West Area.

Ground-water flow beneath the 200-East Area is more complex as a result of the convergence of flow from the west (from the local ground-water flow system) and east (from 216-B-3 Pond artificial recharge). This convergence of flow and other local hydrogeologic conditions have caused ground water within the unconfined aquifer to diverge, with one component flowing northward between Gable Butte and Gable Mountain, and another component flowing southeast toward the Columbia River. This convergence and divergence of ground-water flow is evident on the most current water-table map (Kasza and Schatz 1989). Because of this convergence and divergence and the very small hydraulic gradients that result from the high transmissivity beneath 200-East Area, it is often difficult to define flow directions from water-table maps of the 200-East Area.

In addition, flow directions may change temporarily as rates of wastewater discharge to 216-B-3 Pond and other disposal sites change. However, contaminant plume maps of the Separations Areas can indicate long-term trends in the directions of ground-water flow. Maps showing contaminant plumes originating in the 200-East Area have been published by Serkowski et al. (1988). These plume maps indicate a north-northwest direction of flow in the extreme north-central portion of the 200-East Area and a south-to-southeast direction of flow in the southeast portion of the 200-East Area.

The principal geologic units (see Figure 2.5) controlling the ground-water flow in the Separations Areas are, in ascending order, the Elephant Mountain Member, which acts as a lower confining layer in most areas; the Ringold Formation, which contains both semiconfined and unconfined aquifer components; and the Hanford formation. Basalt of the Elephant Mountain Member is assumed to be the base of the unconfined or uppermost aquifer near the 200-East Area. However, studies by Graham et al. (1984) and Jensen (1987) indicate possible aquifer intercommunication between the unconfined aquifer and the confined Rattlesnake Ridge aquifer near the 200-East Area. The Elephant Mountain Member has possibly been removed by erosion in the vicinity of the northeast corner of the 200-East Area, providing a means for aquifer intercommunication. A zone where the hydraulic gradient is downward occurs between the unconfined aquifer and the uppermost confined Rattlesnake Ridge aquifer beneath 216-B-3 Pond (Graham et al. 1984; Jensen 1987; Kasza and Schatz 1989).

The Ringold Formation exhibits a variety of hydrologic characteristics, including hydraulic conditions ranging from locally confined to unconfined. In the southern portion of the 200-East Area and much of the 200-West Area, the coarse-grained facies of the basal Ringold unit are locally confined by the overlying lower and fine-grained basal Ringold units (Last et al. 1989). In other areas, the fine-grained basal and lower Ringold units are missing, and the coarse-grained basal and/or middle Ringold units contain the unconfined aquifer. In the northeastern portion of the 200-East Area, the Ringold Formation has been completely removed by erosion. Here, the unconfined aquifer lies within the Hanford formation, which directly overlies the basalt (Tallman et al. 1979).

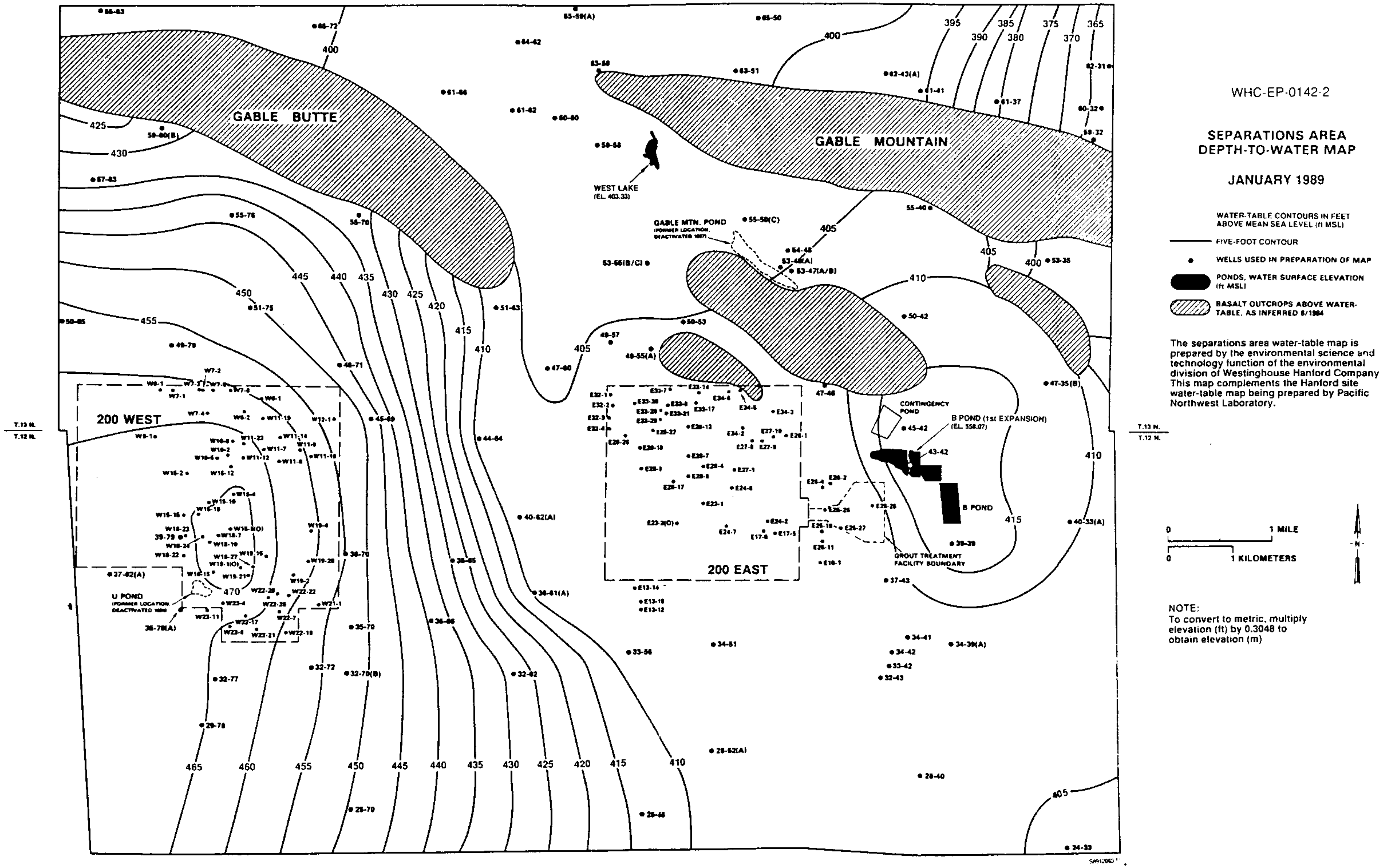

Figure 2.9. Water-Table Map for the Separations Areas, January 1989 (Kasza and Schatz 1989).

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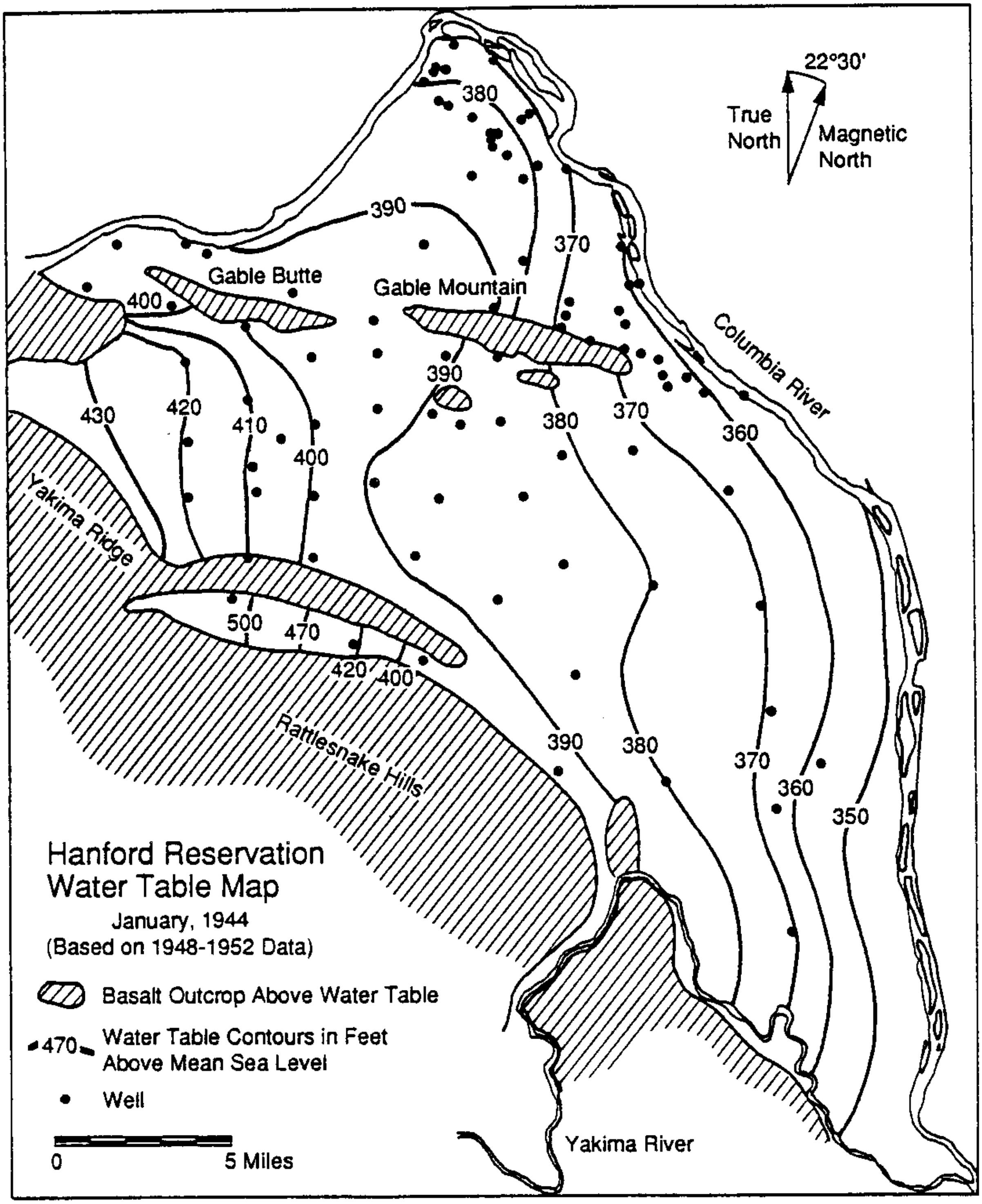

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Figure 2.10. Hindcast Water-Table Map of the Hanford Site, January 1944 (ERDA 1975).

The lithologies in the unconfined aquifer exhibit widely varying hydrogeologic properties (Table 2.3). The values given in Table 2.3 are generalizations; in some locations hydraulic properties may lie outside the ranges given.

In the 200-West Area, the unconfined aquifer occurs primarily within the middle Ringold unit, which is compacted and often partially cemented. Transmissivities range from 300 to 5400 ft^2/d (Graham et al. 1981). In the 200-East Area, the aquifer is in either the unconsolidated Hanford formation or the middle Ringold unit or in both, leading to a range of transmissivities from 5 to 135,000 ft^2/d. Transmissivities generally increase from west to east across the Separations Areas as a result of the thinning of the Ringold Formation.

The measured storativity values for the unconfined aquifer range from 0.002 to 0.07 (Table 2.3); the lower values are associated with the lower Ringold unit and the higher values with the Hanford formation (Graham et al. 1981).

The effective porosity of the sediments in the unconfined aquifer ranges from 10 to 30% (Graham et al. 1981). The lower value corresponds to sediments contained within the lower Ringold unit, and the upper end of the range approaches the total porosity of the sediments contained within the Hanford formation.

Table 2.3. Hydraulic Properties in the Separations Areas (after Graham et al. 1981).

Interval Tested	Hydraulic Conductivity, ft/d	Storativity	Effective Porosity, %
Hanford formation	2,000-10,000	0.07	30
Middle Ringold Unit	9-230	NA[a]	NA
Lower Ringold Unit	1-12	0.002	10

(a) NA = not available.

The chemical composition of the water in the unconfined aquifer ranges between calcium-bicarbonate, sodium-bicarbonate, and calcium-sulfate types (Graham et al. 1981). Calcium-bicarbonate is the most prevalent constituent in the ground water; however, there is considerable variability in chemical composition of the ground water beneath the Separations Areas.

Discontinuous perched water tables occur in localized areas in the 200-West Area, often lying on top of a calcrete horizon in the Plio-Pleistocene unit or above markedly finer-grained sediments in the upper Ringold unit, early "Palouse" soil, and Hanford formation. The lateral extent of these perched water tables has not been defined in detail, but they are believed to be discontinuous and found only near areas where large quantities of water were disposed of to waste facilities.

Hydrogeology Beneath the S-10 Facility

Information on the vadose zone and the uppermost aquifer at the S-10 facility is summarized from well-log data for wells surrounding the crib and from published reports. The as-built diagrams of these wells are presented in Appendix B. Descriptions of the geology and hydrogeology beneath the S-10 facility are available in reports by DOE (1988), Last et al. (1989), and Tallman et al. (1979). Water-level data are available in semiannual reports by Schatz and McElroy (1988) and Kasza and Schatz (1989) and in the Pacific Northwest Laboratory Hanford Ground-Water Data Base. Hydraulic test results from wells on the Hanford Site are available from Kipp and Mudd (1973).

Vadose Zone. The unsaturated zone beneath the S-10 facility extends through a number of recognized stratigraphic units that include, in ascending order, the middle Ringold unit, the Plio-Pleistocene unit, the early "Palouse" soil, and the Hanford formation (Figures 2.6 and 2.7). The thickness of the unsaturated zone in the immediate vicinity of the S-10 facility is approximately 190 ft, based on a May 1989 water level recorded at well 699-32-77. Drilling records do not indicate that perched water was encountered during drilling of wells in the vicinity of the S-10 facility. Drillers' logs indicate that the sediment was dry from approximately 50 ft to 100 ft below land surface in the vicinity of wells 299-W26-3 and 299-W26-6. No other sediment moisture data are available.

Unconfined (Uppermost) Aquifer. For the purpose of planning for initial hydrogeologic characterization, the unconfined aquifer is considered to be the uppermost aquifer, and it is therefore of primary interest for ground-water monitoring. Information on the aquifer conditions beneath the S-10 facility are summarized from well-log data, hydraulic test results, water-table maps, and various published reports.

The unconfined aquifer contained within the sediments overlying the basalts is the uppermost aquifer beneath the S-10 facility. It is therefore of primary interest for ground-water monitoring. Data collected from existing wells near the S-10 facility show that the upper portion of the unconfined aquifer beneath the facilities is contained primarily within the middle Ringold unit (see Figures 2.6 and 2.7). As mentioned in the site geology section above, the base of the aquifer is considered to be either the top of the mud-rich unit (the fine-grained facies of the basal Ringold/lower Ringold units) or, where the mud is not present, the top of basalt. The thickness of the aquifer may range from about 250 to 400 ft, depending on whether the mud-rich unit or the basalt is the base.

Based on existing water-level information, the water table in the immediate vicinity of the S-10 facility is approximately 190 ft below ground surface (well 699-32-77, May 1989). A ground-water mound exists under 216-U-10 Pond, which is to the north of the S-10 facility (Figure 2.9). Hydrographs developed using historical water-level data for wells near the S-10 facility are given in Appendix C. These graphs show a decline in water level after the decommissioning of 216-U-10 Pond.

The current ground-water flow direction is to the east-southeast, based on the water-level contours developed using May 1989 water-level data (Figure 2.11). The direction of ground-water flow is likely to change more as a result of continued dissipation of the 216-U-10 Pond mound.

Transmissivity and hydraulic conductivity of the uppermost aquifer beneath the S-10 facility are estimated by analyzing aquifer test data. A constant-discharge aquifer test was conducted in well 699-32-77 in 1969 (the location is shown in Figure 2.8). Analysis of the results of this test presented by Kipp and Mudd (1973, p. 13) gave values of transmissivity ranging

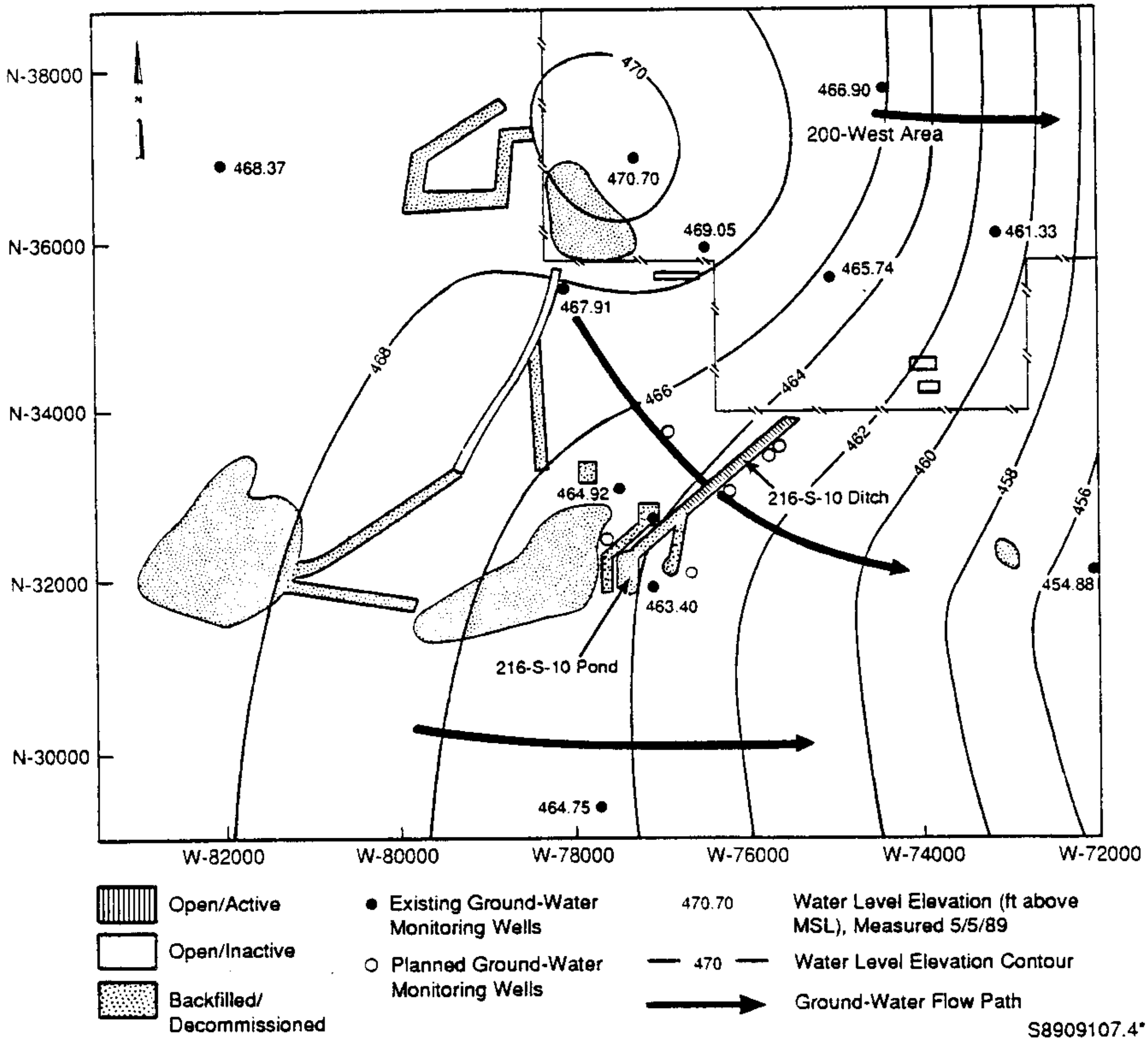

Figure 2.11. Water-Level Elevation Data in the Vicinity of the S-10 Facility.

from 4.5 x 10^3 to 5.7 x 10^4 ft^2/d or a hydraulic conductivity ranging from 40 to 500 ft/d. These results are within the range of hydraulic conductivity reported by Graham et al. (1981) for the middle Ringold unit.

The ground water in wells 299-W26-3, 299-W26-6, 699-29-78, 699-32-72, 699-32-77, and 699-35-78A has been sampled regularly for radionuclides. Well 699-35-78A has also been sampled for metals. In the past, well 299-W22-17 was also sampled for radionuclides. Results of the analysis for these samples are given in Appendix D. The analytical results of the radionuclide analysis were compared to the Derived Concentration Guidelines (DCGs), because there are no drinking water standards for radionuclides. All of the radionuclides analyzed for were below 1/25 of the DCGs. The metals detected in a water sample from well 699-35-78A were all below the EPA's drinking water standards.

PHASE I - GROUND-WATER MONITORING PROGRAM

This plan has been developed in accordance with RCRA, as described in 40 CFR 265, Subpart F, and WAC 173-303 to 1) establish an interim-status ground-water monitoring program that will include background determination and indicator-evaluation of the ground-water quality beneath the S-10 facility, and 2) if necessary, initiate a ground-water quality assessment program for the S-10 facility. All work outlined in this plan will be conducted under the proper procedures and quality assurance plan. In addition, all onsite personnel must meet Occupational Safety and Health Administration (OSHA) medical, monitoring, and training requirements, in accordance with 29 CFR 1910.120.

OBJECTIVES

Specific objectives of the interim-status ground-water monitoring program for the S-10 facility are to

- Characterize the stratigraphy beneath the S-10 facility.
- Determine the horizontal and vertical ground-water flow directions and rates beneath the S-10 facility. The focus will be on the uppermost unconfined aquifer.
- Establish background water-chemistry conditions of the ground water beneath the S-10 facility (background monitoring program).
- Determine whether any statistically significant amounts of hazardous waste constituents originating from the S-10 facility have impacted the ground water beneath the S-10 facility (indicator-evaluation program).
- Prepare an outline for a ground-water quality program for the S-10 facility (see Chapter 4.0).

APPROACH

Installation of two upgradient and four downgradient monitoring wells is planned for an initial ground-water monitoring network for the S-10 facility (Figure 3.1). These wells will provide information on the geology, hydrology, and water quality beneath the S-10 facility. Three existing wells (299-W26-3, 299-W26-6, and 699-32-77) may also be used to supplement this newly installed ground-water monitoring network. The fitness of these

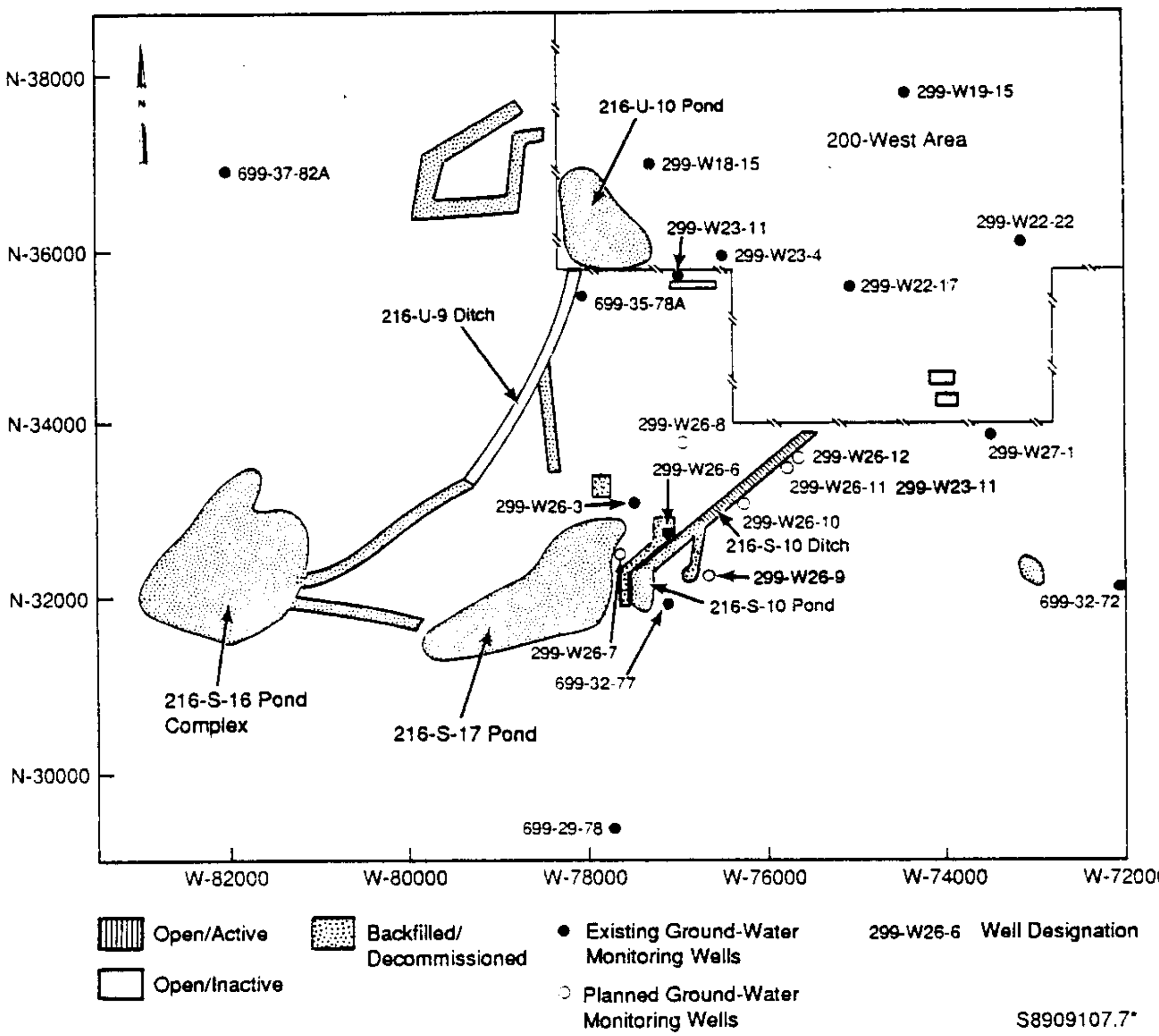

Figure 3.1. Existing and Planned Ground-Water Monitoring Wells.

existing wells for use as monitoring structures will be evaluated according to the evaluation plan outlined in this chapter. If the existing wells meet the evaluation criteria and are incorporated into the ground-water monitoring network, then the total network (new wells combined with existing wells) will comprise four upgradient and five downgradient wells.

Planned wells 299-W26-7 through -11 will be installed within the unconfined aquifer at the water table, approximately 190 ft below ground surface. These wells will provide information on stratigraphy, ground-water flow direction, and water quality from the uppermost portion of the unconfined aquifer. Planned well 299-W26-12 will be installed at the base of the unconfined aquifer, which is presumed to be defined by a thick mud unit approximately 430 ft below land surface. This well will provide information on stratigraphy, vertical hydraulic flow within the unconfined aquifer, and water quality of the lowest portion of the unconfined aquifer.

Subsurface soil samples will be collected during the drilling at each location. These samples will be classified by texture in the field for later identification of stratigraphy. Selected samples will be submitted to the laboratory for analyses to determine various physical and chemical parameters. Ground-water samples may be collected on reaching the water table if such samples are necessary for determining appropriate disposal of purge water during aquifer testing and well development. These samples may be analyzed, before aquifer testing or well development, for the following contamination indicator parameters: volatile organics, gross alpha, gross beta, gamma scan, and nitrate. The aquifer tests, if conducted, will be useful for providing estimates of hydraulic properties of materials beneath the site. Because of the problem of disposing of purge water, it is unlikely that constant-discharge tests will be conducted. Slug tests, however, will be conducted even if constant-discharge tests are not performed. A gross gamma log will be run in each well after the placement of each size casing (except for the 20-ft starter casing) and again upon completion of the well.

Water samples from all new monitoring wells and from selected existing wells will be collected and analyzed quarterly. The first year of sample analyses will be used to establish the background water quality for each well. Statistical evaluation comparing subsequent analyses with these background concentrations may indicate whether hazardous constituents from the S-10 facility are significantly affecting the ground water.

GROUND-WATER MONITORING SYSTEM

This section identifies the aquifer that will be monitored, the location of and justification for the monitoring wells, how the new wells will be installed, the frequency of sampling, and ground-water constituents to be analyzed.

Identification of Aquifer to be Monitored

The uppermost aquifer beneath the S-10 facility is contained primarily within the Ringold Formation. At well 699-32-77, the top portion of the aquifer extends down into the Plio-Pleistocene unit. This uppermost aquifer beneath the S-10 facility extends down from the water table, approximately 190 ft below land surface, to the top of the fine-grained facies of the basal Ringold/lower Ringold unit, approximately 430 ft below land surface. The uppermost aquifer is discussed in more detail in Chapter 2.0. Hydrogeologic characterization activities are designed and planned to obtain information on hydraulic and flow characteristics of the uppermost aquifer.

New Characterization/Monitoring Wells

Six new wells are planned for monitoring the S-10 facility. Installation of these wells will occur in two phases. Phase I, which is scheduled for calendar year 1990, will include construction of three shallow monitoring wells, one upgradient and two downgradient of the S-10 facility. Phase II will include installation of one additional shallow upgradient well and two additional downgradient monitoring wells, one shallow and one deep. The purpose of the shallow wells (299-W26-7 through -11) is to 1) provide upgradient and downgradient ground-water quality information from the upper portion of the unconfined aquifer, 2) provide a means of evaluating the hydraulic and flow properties of the uppermost aquifer, 3) provide information needed to redefine the subsurface stratigraphy beneath the S-10 facility, 4) provide samples to determine the moisture content of the unsaturated zone, and 5) provide samples to determine the vertical distribution of contaminants in the unsaturated and saturated sediments. The deep well (299-W26-12) will differ in purpose from the shallow wells in the following ways: 1) it will provide downgradient ground-water quality information from the lower portion of the unconfined aquifer, 2) it will provide information necessary to define the vertical gradient within the unconfined aquifer, and 3) it will better define the thickness of the unconfined aquifer beneath the S-10 facility.

Additional considerations in locating the new wells are obstacles or drilling hazards, such as buildings, steamlines, cribs, underground piping, power lines, or surface contamination. Areas with known surface contamination should particularly be avoided to prevent the introduction of drilling-induced contamination into the ground water.

Justification for Locations of New Wells. The current direction of ground-water flow in the vicinity of the S-10 facility is to the east-southeast (see Figure 2.11). As discussed in Chapter 2.0, the present flow direction is primarily the result of a temporary ground-water mound that exists as a result of past discharges to 216-U-10 Pond, located approximately 1 mi north of the S-10 facility. This mound has declined since the decommissioning of 216-U-10 Pond and is expected to continue to decline in the future. With this decline, the flow beneath the S-10 facility is expected to change to an easterly direction, as it was in the hindcast water-table map (Figure 2.10). This decline and the subsequent flow direction change complicate the determination of well placement for long-term monitoring around the S-10 facility. The locations chosen for both phases of well installation take into account the expected change in flow direction resulting from the decline of the 216-U-10 Pond mound. An additional complicating factor is the proximity and therefore potential influence of other waste facilities around the S-10 facility. However, the facilities nearest to the S-10 facility have been decommissioned.

Sequencing of Well Installations. The installation of ground-water monitoring wells for the S-10 facility will be divided into two phases. Phase I will consist of installing three wells to meet agreed-upon milestones for calendar year 1990. The well locations for this phase were chosen to provide a broad range of coverage for assessing ground-water quality both upgradient and downgradient of the S-10 facility.

Phase II will consist of installing at least three additional wells around the S-10 facility. The well locations for this phase are tentative and will be based largely on data collected from Phase I installation.

Table 3.1 lists the wells planned for both phases of installation.

Drilling and Well Installation. The cable-tool method of drilling will most likely be used. If another method of drilling is chosen, it will have the same advantages as the cable-tool method. The advantages are 1) drill cuttings are easily contained (important in contaminated material), 2) representative geologic samples can be collected, 3) moisture samples can be collected from above the water table, 4) disturbance to the borehole wall is minimized, and 5) a straight, plumb borehole is produced.

When the borehole is being drilled, the drive-barrel method of sampling is the preferred method for the unsaturated sediments. Both above and below the water table, split-barrel samples, which are the most representative samples, may be collected occasionally to provide samples for permeameter and bulk porosity testing. It is especially important for split-barrel samples to be collected when the mud in planned borehole 299-W26-12 is encountered at approximately 430 ft.

Drill cuttings will be routinely monitored for radiation and hazardous material. Where contamination is suspected, all drill cuttings will be collected until analytical results indicate that the material is not a dangerous waste. If contamination is detected, the drilling will stop until

Table 3.1. Summary of Planned Borehole Depths.

Well No.	Type of Well	Phase of Drilling	Approximate Depth to Water, ft	Approximate Depth of Borehole, ft
299-W26-7	Shallow monitoring	Phase II	188	203
299-W26-8	Shallow monitoring	Phase I	190	205
299-W26-9	Shallow monitoring	Phase I	204	219
299-W26-10	Shallow monitoring	Phase II	204	219
299-W26-11	Shallow monitoring	Phase I	206	221
299-W26-12	Deep monitoring	Phase II	206	430

Westinghouse Hanford has determined what course of action to take. If the level of contamination is significant, such that changes in well design or well location are required, then the Washington State Department of Ecology will be notified by Westinghouse Hanford before the changes are made. Contaminated cuttings will be handled, transported, and disposed of according to Westinghouse Hanford procedures.

To help prevent the introduction of contaminants into the borehole, the drill rigs and peripheral equipment (such as drill tools, cables, and temporary casing) will be steam cleaned before arriving on site, moving to a new site, and beginning construction of the next well. During drilling in the zone to be sampled, the addition of water to the borehole will be kept to a minimum or avoided. This will minimize the need for well development pumping after wells are completed and will minimize the chances of driving any vadose zone contaminants into the ground water.

The temporary casing will be telescoped so that no more than 150 ft of any one size of casing will be in contact with the formation. This will facilitate pulling the temporary casing out of the borehole and make it possible to seal off any potential zones of contamination from the lower parts of the borehole.

Temporary carbon steel casing will be driven to total depth as each borehole is advanced. The minimum diameter of the temporary casing must be 8 in.; however, it is recommended that a larger-diameter casing (e.g., 10-in. diameter or larger) be used to start the borehole in case perched water conditions are encountered. If perched water is encountered, the casing will be telescoped down to seal off the perched zone. If perched water does exist, it is most likely to be encountered directly above the fine-grained sediments of the Early "Palouse" Soil (see Figures 2.6 and 2.7), which generally lie 100 to 150 ft below land surface at the S-10 facility. At the completion of drilling, the final well casing and screen will be installed, and the temporary carbon steel casing will be removed as the filter pack and annular seal materials are placed in the annular space.

Well Construction (Shallow Wells). A schematic diagram of a completed shallow well is presented in Figure 3.2. Guidance concerning geologic

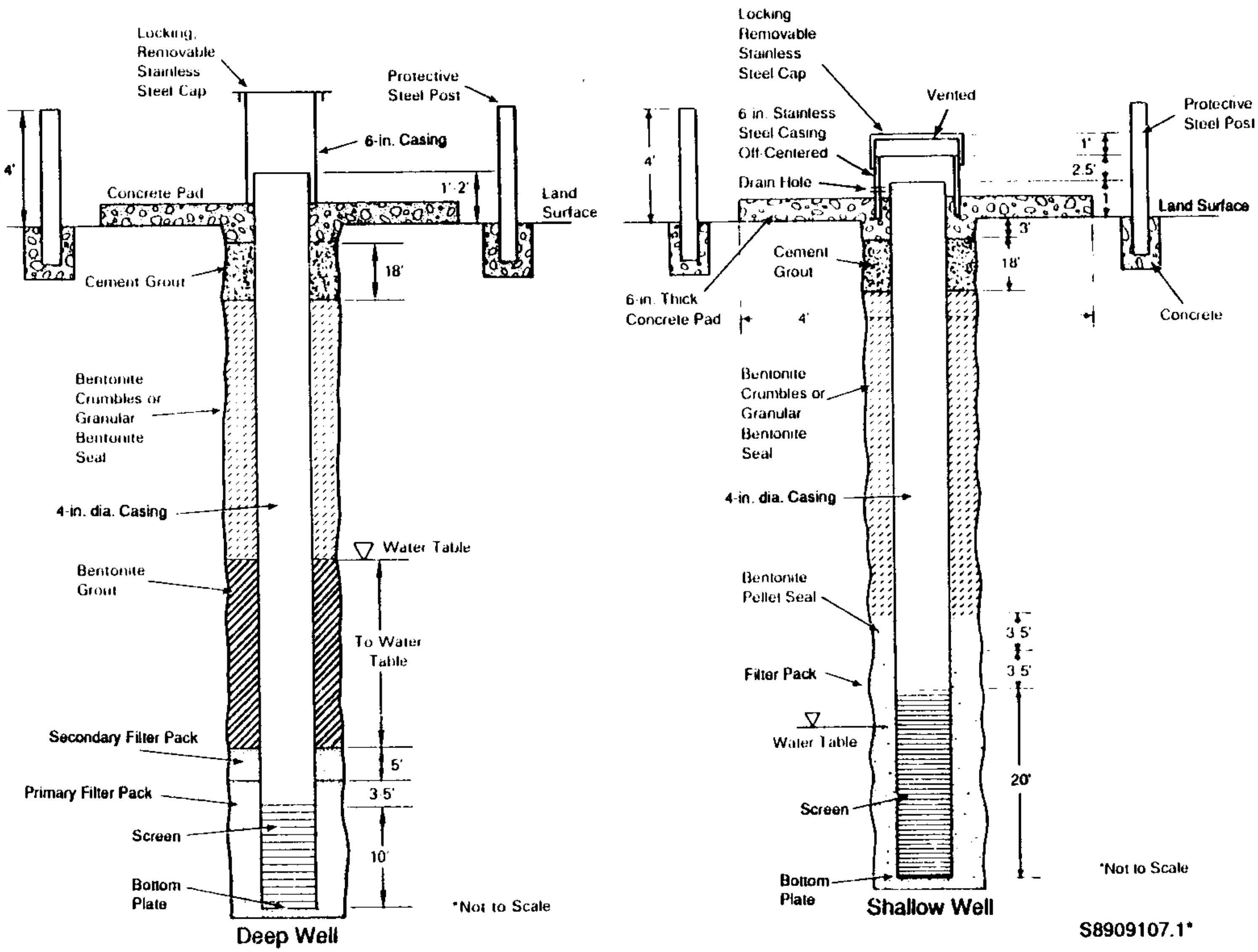

Figure 3.2. Schematic Diagram of Deep and Shallow Well Constructions.

sampling and inspection of well construction has been given by Last and Liikala (1987), and the procedures for ground-water investigations have been presented by PNL (1989). The Minimum Standards for Construction and Maintenance of Wells, WAC 173-160-500 to -560, are the minimum requirements used for designing the wells. Specifications written by Westinghouse Hanford control the design and construction requirements for the monitoring wells.

Shallow wells will be constructed of 4-in.-inside-diameter pipe and screen made from chemically inert materials, such as stainless steel or fiberglass. Final screen lengths will be 20 ft, with approximately 5 ft of screen extending above the water table to allow for possible water fluctuations.

The water-level trend for well 699-32-77 illustrated in Figure C.9 shows that the water table in the vicinity of the S-10 facility has declined approximately 7 ft since late 1984. This trend can be extrapolated to estimate future water levels, assuming that the water-level trend continues uninterrupted. The approximated straight lines for these wells represent the water-level decline and indicate that water levels are declining logarithmically with time. A semilogarithmic plot (Figure 3.3) of time versus decline in water level for wells 699-29-78, 699-32-72, and 699-32-77 shows similar trends for the three wells. Wells 699-29-78 and 699-32-72 show the least decline in water level because they are a greater distance from 216-U-10 Pond. Well 699-32-77 is the well closest to both the S-10 facility and the proposed new well locations. By extending the straight line to the year 2010, it is estimated that the water level in well 699-32-77 will decline about 11.5 ft from its 1984 level or about 4.5 ft from its present level. Based on this estimate, it appears that a screen length of 20 ft will be adequate to provide ground-water monitoring for at least 20 years.

Screen-slot sizes will be selected after sieve analyses of the sediments collected from the screened interval have been performed. The site geologist will determine the filter-pack size and screen-slot size based on guidelines outlined by Last and Liikala (1987). Channel-pack screens can be used for the completion. A sand filter pack will be placed from approximately 1 ft below the bottom of the screen to 3 ft above the top of the screen.

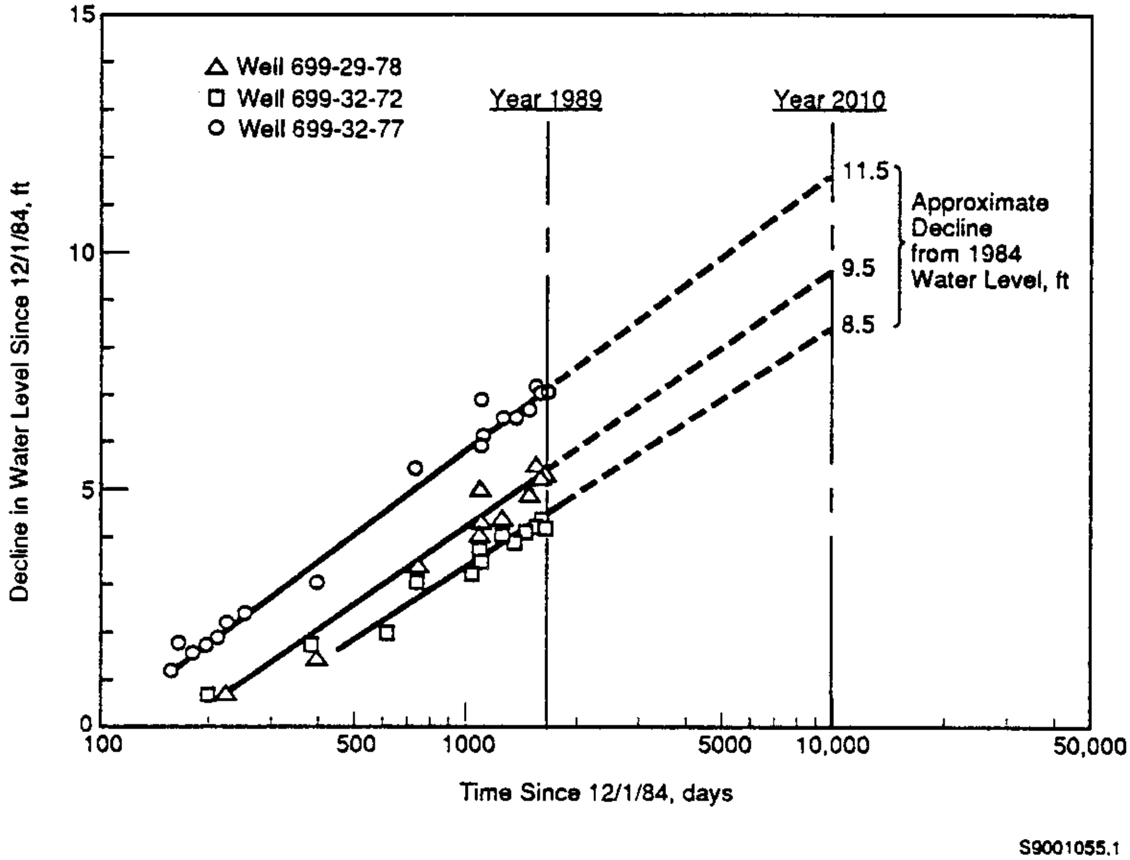

Figure 3.3. Semilogarithmic Plots Showing Decline of the 216-U-10 Pond Ground-Water Mound at Three Wells Near the S-10 Facility.

A 2- to 3-ft-thick bentonite pellet seal will be placed on top of the sand pack. The annulus from above the bentonite pellet seal to 18 ft below ground surface will be filled with bentonite. Cement grout will then be installed to within 2 ft of the ground surface. The well casing will extend 1 to 2 ft above ground surface and will be protected by an outer steel casing and a locking cap. The casing will be set into the ground and cemented in place with a 4-ft by 4-ft by 6-in. concrete pad. A brass survey marker will be placed in the concrete pad, and all protective casings will be permanently marked with well identification numbers.

Well Construction (Deep Well). A schematic diagram of a completed deep well is presented in Figure 3.2. Guidance concerning geologic sampling and inspection of well construction has been given by Last and Liikala (1987), and the procedures for ground-water investigations have been presented by PNL

(1989). The Minimum Standards for Construction and Maintenance of Wells, WAC 73-160, were used as guidance for designing the wells. Specifications written by Westinghouse Hanford control the design and construction requirements for the monitoring wells.

The deep well will be constructed using 4-in.-inside-diameter pipe and screen made from chemically inert materials, such as stainless steel or fiberglass. The final screen length will be 10 ft. Screen-slot sizes will be selected after sieve analyses of the sediments collected from the screened interval have been performed. The site geologist will determine the filter-pack size and screen-slot size based on guidelines outlined by Last and Liikala (1987). Again, channel-pack screens may be used in this completion. As the temporary casing is withdrawn, sand filter packs will be placed in the annulus between either the 8-in. telescoping screen or the temporary 8-in. casing and the permanent 4-in. casing and screen. If a telescoping screen is used during tests, it will be left in the hole. The sand filter pack will be placed from approximately 1 ft below to 3 to 5 ft above the top of the screen. Approximately 1 ft of secondary filter pack, consisting of a fine-mesh silica sand (i.e., 40-100 mesh), will be placed on top of the primary filter pack.

From the top of the secondary filter pack to the water table, bentonite grout or bentonite slurry will be placed using the tremie method. Dry bentonite will be emplaced from the level of the grout or slurry to approximately 18 ft below land surface. The annulus above the dry bentonite pellet seal to within 2 ft of land surface will be filled with cement grout. The well casing will extend 1 to 2 ft above ground surface and will be protected by an outer steel casing and a locking cap. The casing will be set into the ground and cemented in place with a 4-ft by 4-ft by 6-in. concrete pad. A brass survey marker will be placed in the concrete pad, and all protective casings will be permanently marked with well identification numbers.

It may also be beneficial to determine the deviation of the boreholes from the vertical, because this deviation can affect the accurate measurement of the depth to water.

Well Development. All wells will be developed following completion. Wells will be developed by the surge-and-bail technique, overpumping, or other reasonable techniques that are deemed necessary until the turbidity is less than 5 NTU and sediment content is less than 8 mg/L. If the water cannot be developed to a turbidity of less than 5 NTU, an explanation will be documented by the site hydrogeologist.

Other hydrochemical indicators, such as total iron and drilling fluid tracers, may also be monitored to assess the adequacy of development pumping for trace constituent sampling.

All ground water discharged from the well during development will be disposed of in accordance with Westinghouse Hanford guidelines and procedures.

Existing Wells

Three wells will be evaluated for use as ground-water monitoring wells in the S-10 facility network. These wells (299-W26-3, 299-W26-6, and 699-32-77) were initially chosen based on their proximity to the S-10 facility. The construction details for each of these three wells are summarized below, based on a review of the respective drillers' logs. The as-built diagrams for these wells are included in Appendix B.

Well 299-W26-3. This well is one of a series of five wells (299-W26-1 through -5) drilled near the S-5 Crib (see Figure 2.1) in 1954. Well 299-W2-63 was the only well of the five that penetrated to ground water (drill depth is 190 ft). The well was drilled only 3 ft into the water table. There is no discussion of well completion in the driller's log; therefore, it appears that the casing (178.5 ft of 8-in. carbon steel) was left stationary upon completion of drilling. A recent depth-to-bottom measurement taken August 25, 1989, was recorded at 188.89 ft below the top of casing. The most recent water level in the borehole (May 5, 1989) was recorded at 186.01 ft below the top of casing. Based on these measurements, it is apparent that only 2.5 to 3 ft of water stands in the borehole.

Well 299-W26-6. This well was drilled to a depth of 227 ft in 1983. A 6-in.-diameter, 20-slot, stainless steel telescoping screen was installed from 191 to 221 ft. A 5-ft stainless steel blank pipe with a packer was connected to the top of the screen. A 6-in.-diameter carbon steel casing extends from the top of the packer to ground surface. The annular spaces between the 6-in. and 8-in. casing and the 8-in. and 10-in. casing were filled with grout. The initial depth to water was recorded by the driller as 190 ft on March 8, 1983. No more recent water-level measurements have been obtained at this well.

Well 699-32-77. This well was drilled to a depth of 291.7 ft in 1951. An 8-in. carbon steel casing extends the entire length of the borehole. The casing is perforated from 185 ft to 290.7 ft. No other completion activities are recorded in the drillers' logs. In 1977, the well was perforated from 175 ft to 185 ft. The well was then filled with an unknown material (possibly surface sediments) to a depth of 235 ft. A 10-ft-thick cement plug was then emplaced on top of this material. The well was brushed and bailed in 1978 and 1983. The most current depth to water (June 9, 1989) was recorded as 190.35 ft below the top casing.

Justification and Use of Existing Wells. The following are the primary advantages for using existing wells: 1) Historical data, which are useful in tracking trends and changes, exist for the wells, 2) Meaningful data can be obtained without installing a new monitoring structure, and 3) At a minimum, existing wells provide useful geologic and hydrologic information that aids in characterization of the waste management area. The three existing wells will be evaluated according to the evaluation plan outlined below.

Evaluation Plan. The existing wells will be evaluated for their utility in the S-10 ground-water monitoring network in three general ways:

- Geologic and Drilling Log Evaluation - The logs of the existing wells will be evaluated for construction details, proper location, and perforated intervals. If it is determined that there is a problem with the construction (e.g., poor annular seal, severe problems during drilling or construction), the well either will be remediated (if possible) or will not be used. This activity will be performed before quarterly collection and analyses begin.

- Visual Inspection - The wells will be inspected at the surface for the integrity of the casing and concrete pad. The wells will also be inspected by downhole camera. If problems with encrustation or integrity are obvious, the wells either will be remediated (if possible) or will not be used. This inspection will be performed before quarterly collection and analyses begin.
- Comparison with Data from New Wells - Water-chemistry data collected from the existing wells will be compared with data collected from the new wells for correlation. If the data do not correlate for selected parameters when they would be expected to, further evaluation will be conducted to determine whether the well should be remediated or whether it should be eliminated from the monitoring system. This evaluation will be performed during and after completion of four quarters of ground-water sampling and analyses.

Monitoring Network

The S-10 facility ground-water monitoring network will consist of at least six wells (2 upgradient and 4 downgradient), which will be installed in two phases. In addition, three existing wells will be evaluated for their use in the monitoring network. If the existing wells meet the evaluation criteria and are incorporated into the ground-water monitoring network, then the total network (new wells combined with existing wells) will comprise four upgradient and five downgradient wells.

Background (Upgradient) Wells. The following wells will monitor ground water upgradient of the S-10 facility:

Well 299-W26-3: This well may be used to evaluate the water quality upgradient of the S-10 facility. Because of its location relative to the 216-S-6 Crib, it would also aid in identifying influences from the crib on ground-water quality beneath the S-10 facility.

Well 299-W26-6: This well may be used to evaluate the water quality upgradient of the S-10 facility. Because of its location relative to the

216-S-5 Crib, it would also aid in identifying influences from the crib on ground-water quality beneath the S-10 facility.

Well 299-W26-7. This well will be used to evaluate the water quality upgradient of the pond portion of the S-10 facility. This well, however, will be located downgradient of the 216-S-17 Pond, which may influence ground-water quality beneath the S-10 facility. The well will be placed close to the east boundary of the 216-S-17 Pond to avoid ground-water chemistry influences from the S-10 facility. The necessity to avoid surface contamination may be a large factor in choosing the final location for this well.

Well 299-W26-8. This well will be used to evaluate the water quality upgradient of the S-10 facility. This well will be located downgradient of the 216-U-10 Pond and the 216-U-9 Ditches, which may influence ground-water quality beneath the S-10 facility. The well will be placed approximately 300 ft from the boundary of the S-10 facility to avoid ground-water chemistry changes from the S-10 facility. This well is expected to continue to provide upgradient monitoring of the S-10 facility as the ground-water flow direction changes as a result of the decline of the 216-U-10 Pond ground-water mound.

Detection (Downgradient) Wells. The following wells will monitor ground water downgradient of the S-10 facility:

Well 299-W26-9. This well will be used to evaluate ground-water quality downgradient of the S-10 facility and the 216-S-11 Pond. This well will be located approximately 100 ft from the east boundary of the 216-S-11 Pond.

Well 299-W26-10. This well will be used to evaluate ground-water quality downgradient of the central portion of the S-10 facility. The location of this well was chosen so that it would provide downgradient ground-water monitoring for the central portion of the 2250-ft-long S-10 facility, along the same approximate flowline as upgradient well 299-W26-8. The well will be placed approximately 100 ft from the boundary of the S-10 facility.

Well 299-W26-11. This well will be used to evaluate ground-water quality downgradient of the S-10 facility. This well will be located approximately 100 ft from the northeastern border of the S-10 facility. This well will provide downgradient coverage of the portion of the S-10 facility that continues to receive waste water.

Well 299-W26-12. This deep well will be placed approximately 20 ft from well 299-W26-11, along the northeast portion of the S-10 facility. There are two primary reasons for the installation of this well: 1) it is adjacent to the portion of the facility that is continuing to receive wastewater (i.e., where vertical flow may exist), and 2) it will continue to provide a monitoring point at the bottom of the aquifer as the ground-water flow direction changes toward the east.

Well 699-32-77: This well may be used to evaluate the water quality downgradient of the pond portion of the S-10 facility. This well would also be useful in comparing ground-water quality data between the southwest and northeast corners of the S-10 facility.

Surveying

After monitoring-well installation is completed, the location and elevation of all wells will be surveyed by qualified surveyors. The elevation of the top of the casing and a brass marker in the concrete pad will be determined within 0.04 ft. A mark will be placed on the casing to indicate the location that was surveyed. The areal location will be determined to the nearest 0.5 ft. All measurements will be referenced to a common datum (preferably a Hanford Site datum).

Monitoring Parameters

Ground-water samples will be collected during each quarter at a minimum, for constituents listed in Table 3.2, in conformance with 40 CFR 265, Subpart F. In addition, constituents listed in the Sampling and Analysis Plan, as contained in Appendix E, will be analyzed once during the first year of sampling.

GEOLOGIC AND HYDROGEOLOGIC CHARACTERIZATION

Hydrogeologic characterization will be conducted to describe the geologic and hydrogeologic conditions and properties that control contaminant

Table 3.2. Ground-Water Sampling Parameters,[a] Maximum Level.

Interim Primary Drinking Water Standards	Maximum Level[b]
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Fluoride	1.4 to 2.4
Lead	0.05
Mercury	0.002
Nitrate (as NO_3^-)	45
Selenium	0.01
Silver	0.05
Endrin	0.0002
Lindane	0.004
Methoxychlor	0.1
Toxaphene	0.005
2,4-D	0.1
2,4,5-TP Silvex	0.01
Radium	5 (pCi/L)
Gross alpha	15 (pCi/L)
Gross beta	4 (mrem/yr)
Turbidity (surface water only)	1 (TU)
Coliform bacteria	1/100 (mL)
Ground-Water Quality Parameters[c]	
Chloride	
Iron	
Manganese	
Phenols	
Sodium	
Sulfate	
Ground-Water Contamination Indicator Parameters[c]	
pH	
Specific conductance	
Total organic carbon	
Total organic halogen	

(a) Regulatory requirements for sampling parameters are subject to change because of federal regulations.
(b) Unless otherwise noted, concentrations are in mg/L.
(c) Maximum (or minimum pH) levels are not yet established.

flow paths. Data collection and interpretation will focus on geology, geochemistry, hydrogeology, hydrochemistry, ground-water monitoring, and ground-water modeling. Work performed by PNL will follow a Quality Assurance Project Plan meeting EPA requirements of QAMS 005/80 (Stanley and Verner 1983). The characterization effort will be performed during and after construction of the planned ground-water monitoring network. An outline of the work to be performed is included below. Information obtained from the existing wells and from new wells drilled at the S-10 facility will also be integrated into the characterization and interpretation. Characterization is a discovery process, and data collection in these areas may expand or decrease depending on the information obtained.

Geologic Characterization

The following activities will be conducted in support of geologic characterization:

Geologic Sampling. Geologic samples will be collected at 5-ft intervals [as recommended by EPA (1986)], at changes in lithology, and when significant changes in moisture content are observed during drilling. A general description of the borehole cuttings between sampling intervals should be recorded by the well-site geologist to obtain a continuous lithologic record. So that perched water zones can be detected, representative moisture samples can be taken, and water chemistry will not be affected, no drilling fluids will be added to the borehole unless necessary and approved by the well-site geologist. Samples will be collected for moisture-content determinations in the unsaturated sediments at 5-ft intervals and at moist or wet zones.

Lithologic samples collected will be described in the field and documented on geologic log forms. Samples will be archived for possible future analyses. A guide to subsurface data collection and documentation during cable-tool drilling has been presented by Last and Liikala (1987), and the procedures for ground-water investigations have been presented by PNL (1989).

Sample Analysis. Geologic samples may be analyzed in the laboratory using the following methods:

- sieve particle size

- pipette and/or hydrometer analyses
- permeameter testing
- calcium carbonate content analysis
- moisture content analysis
- petrography
- x-ray diffraction
- x-ray fluorescence
- atomic absorption analysis
- bulk mass density
- hazardous chemical analysis
- radionuclide analysis.

Some of these methods may be performed on sediments from every 5-ft sample interval (e.g., sieve particle size, calcium carbonate), while other methods apply only to particular types of sediment samples or at irregular sample intervals. Table 3.3 summarizes the frequency, limitations, and requirements for samples to be analyzed by the various methods.

Sediment Collection and Analysis. In addition to geologic samples, sediment samples may be collected for chemical and radiologic analysis. These samples will be collected following the frequency outlined below:

- at approximately every 20 ft over the entire length of the borehole
- at major lithologic changes
- at perched water zones or zones of increased moisture content
- at zones where contamination is suspected based on unusual soil discoloration, odor, or detection instrumentation response above background.

All samples will be collected and kept in refrigerated storage under the proper chain of custody procedures. Immediately after a borehole has been drilled to depth, the geologist and the project manager will select certain samples to be analyzed. The first samples chosen for analysis will be from zones of suspected contamination, the next from changes in lithology, the next from below the water table, and the final ones to fill in the gaps

Table 3.3. Laboratory Analyses to be Performed as Part of Hydrogeologic Characterization.

Laboratory Analysis	Parameter Measured	Sample Requirements/ Limitations	Potential Uses	Sample Frequency	Method of Sample Collection *
Sieving	Particle-size distribution of sand to gravel-size particles	Individual soil particles must be disaggregated and unbroken to yield accurate results	Proxy for hydraulic parameters; ground-water modeling	All samples	SS, DB, HT
Hydrometer	Particle-size distribution of mud-size particles (i.e., silt and clay)	Fine grained; undisturbed/intact soils	Characterize aquitards; ground-water modeling	All fine-grained intervals	SS, DB
Permeameter	Saturated hydraulic conductivity	Undisturbed/intact soils	Determine rate of ground-water movement; check for aquifer tests; ground-water modeling	Selected intervals	SS
Calcium carbonate	%$CaCO_3$	Soils of fine sand or smaller particles	Aquitard identification; stratigraphic marker horizons	All samples	SS, DB, HT
Moisture content	% Water	Undisturbed/intact soils	Evaluate vadose water movement; aquitard identification; ground-water modeling	All fine-grained intact intervals	SS, DB
Petrography	Mineral content/ concentration	Soils with sand and larger particles	Differentiate among hydrostratigraphic units	Selected samples where major geologic contacts are suspected	SS, DB, HT
X-ray diffraction (XRD)	Clay mineral identification	Soils with mud-size particles	Sorptive characteristics; hydrostratigraphic unit identification	Selected fine-grained intervals	SS, DB, HT
X-ray fluorescence (XRF)	Major and trace element concentrations (except sodium and magnesium)	Intact soils or soils uncontaminated with overlying material	Hydrostratigraphic unit identification, determine background levels of constituents in soils	Selected intervals where lithology changes	SS, DB, HT
Atomic absorption	Sodium and magnesium concentrations	Intact soils or soils uncontaminated with overlying material	Hydrostratigraphic unit identification; determine background levels of constituents in soils	Selected intervals where lithology changes	SS, DB, HT
Bulk mass density	Bulk porosity	Undisturbed/intact soils	Determine hydraulic parameters; ground-water modeling	Selected intervals	SS
Hazardous chemicals	Concentrations of hazardous constituents in ground water	Nonturbid ground water; soil samples	Determine presence/ absence of ground-water contamination	All ground-water-bearing zones at regular intervals	Pump from completed well
Radionuclides	Concentrations of radionuclides in ground water	Nonturbid ground water; soil samples	Determine presence/ absence of ground-water contamination	All ground-water-bearing zones at regular intervals	Pump from completed well

*
SS = split-spoon drill method
DB = drive-barrel drill method
HT = hard-tool drill method

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between the samples selected according to the first three criteria. Each sample may be analyzed for one or more of the constituents listed in Table 3.4, using the methods and laboratories listed.

Borehole Logging. After each string of a given casing diameter is emplaced, and when the monitoring wells have been drilled to the final depth, the borehole will be logged with a gross gamma probe according to the procedure outlined in PNL-MA-567 (PNL 1989). Logging will not be conducted within the 20-ft starter casing. The primary purpose of geophysical logging will be to correlate and interpret subsurface stratigraphy between boreholes. Specifically, the gross gamma log is useful for providing an indication of the clay content of the formation. In many cases, the fine-grained sedimentary layers produce a higher gamma activity than coarse-grained sediments. Another use is to identify zones of suspected contamination by gamma-ray-emitting radionuclides. After completion, each well will be viewed with a downhole video camera to ensure that the well is clean and undamaged. The neutron, density, caliper, spontaneous potential, resistivity, and magnetic probes and the

Table 3.4. Constituents and Methods for Soil Analysis.

Constituent	Method	Lab[a]
Uranium	PNL-SP-19	PNL
Chromium	PNL-SP-19	PNL
Lead	PNL-SP-19	PNL
Selenium	PNL-SP-19	PNL
Major elements	PNL-SP-19	PNL
TOC	EPA Method 9060	US Testing
Volatile organics	EPA Method 5030/8020	PNL
Cation exchange	EPA Method 9080/9081	US Testing
Anions	US Testing Method	US Testing
Gross alpha	EPA Method 9310	US Testing
Gross beta	EPA Method 9310	US Testing
Gamma scan	US Testing Method	US Testing

(a) PNL = Pacific Northwest Laboratory
US Testing = United States Testing Company, Inc.

downhole video camera may also be used in specific instances when approved by Westinghouse Hanford. Spectral gamma logging may be performed by Westinghouse Hanford.

Data Interpretation and Presentation. All geologic and geophysical data will be interpreted to determine the stratigraphy beneath the site. These data will be presented in cross sections, fence diagrams, contour maps, and tables, as recommended by EPA (1986). Interpretations of the stratigraphy will be used in evaluating potential contaminant flow paths and in determining the hydrostratigraphic units beneath each waste management area, and they will aid in locating additional characterization and monitoring wells, if needed.

The data and interpretations will be presented in an interim site characterization report and in permitting documents. The documents will specifically include 1) descriptions of stratigraphic units, 2) results of analyses, 3) as-built diagrams of wells, and 4) recommendations for further characterization or additional monitoring wells, if necessary.

Hydrogeologic Characterization

Data will be collected during and after drilling of the monitoring wells that will be used to characterize the hydrogeology beneath each waste management area. The general types and methods of data collection are discussed below. Ground-water samples will be taken following the procedures discussed in the sampling and analysis plan (Appendix E) or their revised, approved, and documented equivalents.

Aquifer Testing. The purpose of aquifer testing is to determine the hydraulic characteristics of in situ geologic materials in the uppermost aquifer underlying the S-10 facility. A field-testing program is essential to optimize collection of hydrologic data. However, the primary purpose of installing the wells is monitoring the ground-water chemistry and not aquifer testing. Therefore, the results must be considered with this perspective.

Aquifer testing that involves pumping ground water out of the well will be conducted only if adequate means exist for disposing of the purge water when the wells are ready for testing. A ground-water sample may be collected and analyzed before aquifer testing begins. The results may be used to determine the handling and disposal of purge water. Slug testing will probably be used because of the problem of disposing of purge water.

A bailer will be used to remove drilling fluids and coarse materials from the borehole. After bailing, pretest development will be conducted by pumping. The purpose of these tests is to develop the well. Pretest development by pumping can be used to determine the optimum discharge rate and, thus, the pump size for the constant-discharge test. If the pump has a check valve, then pretest development will consist of pumping at a low flow rate followed by successively higher flow rates until full pump capacity or maximum drawdown has been achieved. If the pump is not equipped with a check valve, a surging technique will be used, in which the pump is alternately turned on and off, followed by step pumping as described above. The constant-discharge test will not be performed until water levels have fully recovered from the development test.

A number of aquifer test methods may be used in the field-testing program depending on the hydrologic parameter sought and on existing hydraulic test conditions. Common test methods include bailer, slug, development, constant-discharge, and recovery techniques. Constant-discharge tests could be conducted for up to 24 h in those cases where at least one observation well is available and drawdown is large enough (greater than 0.2 ft) to allow a quantitative analysis of the data. When available, data from the observation wells can be analyzed to yield estimates of transmissivity, storativity, and sometimes hydraulic conductivity anisotropy. Results from constant-discharge tests can also be used to verify lateral continuity. Single well constant-discharge tests can normally be conducted for up to 8 h. Tests of 8-h duration can be used to estimate transmissivity.

A constant-discharge pumping test should be conducted in one upgradient and one downgradient well. If a constant-discharge pumping test is to be conducted, a temporary section of nominal 8-in. telescoping screen will be set in each of the wells before pumping. The length of the temporary screen will be similar to the screen lengths of the completed well. The screen will be open to the uppermost portion of the aquifer.

A submersible pump will be placed in the bottom portion of the screened interval. If the sediments in the test interval appear to have relatively high permeabilities, such as those characteristic of the Hanford formation, a high discharge rate will be required. The largest pump size that will fit in a nominal 8-in. telescoping screen (normally 40 hp) will be used in this case because it is expected that even a maximum discharge from this size pump (200 to 250 gpm) will produce only a small drawdown (no more than 2 ft).

If sediments in the test interval have low permeabilities, such as those characteristic of the Ringold Formation, a much lower discharge rate will be required, and a smaller pump can be installed. In some locations, the sediments in a test interval may be of such low permeability that a pumping test would not be possible. In these situations, a slug test may be conducted.

A slug test may be conducted in the following manner: The drive casing will be pulled back a few feet to expose the formation to the open hole. If heaving or caving formations are expected, a temporary section of telescoping screen will be set in the well before testing. The screen may be set as described for the constant-discharge pumping test. The borehole will be bailed to remove drilling fluids and debris before the test is conducted. During the slug test, the hydraulic head will be changed instantaneously by suddenly introducing or removing a cylinder of known volume. The water-level recovery response will then be observed over time.

A slug test will not yield representative results if the interval being tested is of heterogeneous materials with hydraulic conductivities that range over several orders of magnitude. In such a case, split-spoon samples may be collected, and laboratory tests may be used to determine hydraulic conductivity.

One or two days of continuous water-level monitoring will be conducted (if scheduling permits) before and/or after terminating the pumping tests. These data will be used to determine whether outside influences, such as barometric effects, will have a significant impact on the tests. If so, the data will be corrected for these effects.

The conventional analysis methods described by Cooper and Jacob (1946) and Theis (1935) can be used to estimate transmissivity in the unconfined aquifer (Graham et al. 1981). Modifications of these methods can be used to correct for partial penetration effects, delayed yield response, leakage effects, and borehole storage effects. Slug-test methods that can be used include those described by Hvorslev (1951), Cooper et al. (1967), and Bouwer and Rice (1976). The laboratory methods to determine hydraulic conductivity include the falling-head or constant-head permeameter tests (Klute and Dirksen 1986).

Determination of Ground-Water Flow Paths. Water levels will be measured in all new wells and in all suitable existing wells nearby to determine the hydraulic head distribution used in identifying ground-water flow paths. Measurements will also be made over time to evaluate temporal changes in flow paths. Techniques used to measure water levels will include acceptable manual methods (e.g., using a standardized steel tape) or automated methods (e.g., calibrated submersible pressure transducer). The data will be integrated to conceptualize three-dimensional flow paths.

Data Interpretation and Presentation. Hydrogeologic data interpretation was discussed, in part, above. These data will be integrated to form a preliminary conceptual model of ground-water flow for the site. Components of the model will include the current determination and description of hydrostratigraphic units, ground-water flow paths, estimates of ground-water velocity, and hydrochemical characterization.

The data will also be used to evaluate whether the characterization is adequate and whether the ground-water monitoring system is appropriately designed. Recommendations may be provided for additional characterization activities or additional ground-water monitoring wells, if necessary.

The data and interpretations will be presented in an interim characterization report and in permitting documents. The report will specifically include 1) descriptions of hydrostratigraphic units, 2) water-level data and water-table maps, 3) test data and results of analyses, 4) as-built diagrams of wells, 5) hydrochemistry data, and 6) recommendations for further characterization or additional monitoring wells, if necessary.

SAMPLING AND ANALYSIS

The wells will be sampled quarterly for 1 year and semiannually thereafter, in accordance with 40 CFR 265.92. HydroStar* sampling pumps will be installed in the new wells soon after construction and well development. Some of the existing wells currently have submersible pumps. A recent study on the effects of sampling with submersible pumps found no appreciable differences between wells sampled with submersible pumps verses wells sampled with bladder pumps or bailers (Liikala et al. 1988). As a result, submersible pumps will continue to be used in existing wells. The depth to water will be measured before samples are collected. The wells will be purged and samples will be collected after at least three borehole volumes have been removed; when specific conductance, temperature, and pH have stabilized; or, in the case of wells completed in very-low-permeability materials, after the well has recharged.

Sample analysis, preservation, and chain-of-custody procedures in accordance with 40 CFR 265.92 are discussed in Appendix E. The quality assurance/control protocol is also given in Appendix E. The purpose of the quality control activities is to determine and document that samples were carefully collected and transferred to an analytical laboratory, to determine and document that the quality of the analytical results being produced by the laboratory are defensible, and to ensure that corrective actions will be taken as necessary.

Under the indicator-evaluation monitoring program, ground-water surface-elevation data will be evaluated at least annually to determine whether the existing monitoring wells are appropriately located. If the evaluation indicates that existing wells are no longer adequately located, the ground-water monitoring system will be modified to bring it into compliance with 40 CFR 265.91(a).

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*HydroStar is a registered tradename of Instrumentation Northwest, Incorporated, Redmond, Washington.

STATISTICAL ANALYSIS OF GROUND-WATER MONITORING DATA

The methods for establishing background and evaluating water-chemistry data and the requirements for reporting are discussed below.

Methods

Quarterly samples will be collected from the ground-water monitoring wells for chemical analyses for one year for the constituents listed in Table 3.2, in conformance with 40 CFR 265.92. Additions to this list may be made based on an evaluation of the initial results. The samples will be analyzed by United States Testing Company, Inc. (UST). The first set of samples will be collected after the wells have been completed and developed, and the sampling pumps have been installed. Depths to water will be measured before the wells are purged.

After one year of quarterly monitoring, background levels for indicator parameters will be determined, to be compared with indicator parameters from downgradient wells semiannually, in accordance with 40 CFR 265.93. The data will be analyzed to evaluate whether ground water is affected by the S-10 facility.

Establishing Background

Background summary statistics (mean, variance, and coefficient of variation) will be calculated from the first four quarterly data sets from the upgradient wells. The actual method to be used for calculating summary statistics will depend on the distribution of the data and the presence of any data reported as less than the limit of detection. Replicate summary statistics will be calculated each quarter. Background comparison summary statistics will be calculated from the quarterly summary statistics.

Samples will then continue to be collected and analyzed semiannually from the upgradient wells. The data will be evaluated to determine whether trends are present, irregularities exist in the data, or ground water from the wells is affected by the S-10 facility. If any of these conditions occurs, the data will be evaluated in relation to the hydrologic system to determine whether the background levels should be recalculated from a new set of quarterly sample data. The data will also be evaluated to determine if the wells being used are suitable for that purpose or if different wells are required.

Evaluation of Data

Wells will be sampled at least twice each succeeding year after background concentrations have been established. A minimum of four replicate measurements will be obtained from each well for the indicator parameters, and the arithmetic mean and variance for the indicator parameters will be calculated for each sample.

The Student's t-test, as presented in the RCRA TEGD (EPA 1986), will be used to determine statistically significant changes in the concentration of indicator parameters of downgradient wells as compared to initial background concentrations or values. This comparison will consider each of the wells in the monitoring system individually. For three of the indicator parameters (specific conductance, total organic carbon, and total organic halogen), a single-tailed Student's t-test will be used to test at the 0.01 level of significance for significant increases over background. The difference test for pH will be a two-tailed Student's t-test at the overall 0.01 level of significance.

Notification and Reports

A summary of the reports required for compliance with 40 CFR 265, Subpart F, is given in Table 3.5.

Table 3.5. Reports Required for Compliance with 40 CFR 265, Subpart F, for Ground-Water Monitoring.

Submittal	Submittal Period
First year of sampling: Concentrations of interim primary drinking water constituents, identifying those that exceed the limits listed in Table 3.2.	Quarterly reports according to the current schedule
Concentration and statistical analyses of ground-water contamination indicator parameters, noting significant differences in downgradient wells.	Annually, according to the current schedule
Results of ground-water surface elevation evaluation and description of response, if appropriate.	Annually, according to the current schedule

PHASE II - INITIATION OF A GROUND-WATER QUALITY ASSESSMENT PROGRAM

This chapter discusses the criteria that would trigger notification of regulatory agencies and initiate a ground-water quality assessment program. The notifications for compliance with 40 CFR 265, Subpart F, are presented, and the contents of the ground-water quality assessment program are outlined.

GROUND-WATER QUALITY ASSESSMENT PROGRAM

Ground-water samples from all monitoring wells will be tested quarterly for contamination indicator parameters, interim primary drinking water constituents, secondary ground-water quality parameters, and site-specific parameters for the first year of sampling. [Background levels of the ground-water contamination indicator parameters will be established statistically after this first year of sampling, using methods recommended in the RCRA TEGD (EPA 1986)]. Once the background for the indicator parameters has been established, subsequent samplings from the S-10 facility monitoring network will be statistically compared (EPA 1986) to the established background values to determine whether there is a significant difference. If a difference is found, the wells in question will be resampled immediately. If the results are verified, the Washington State Department of Ecology will be notified in writing within 7 days of verification. A ground-water quality assessment program will then be developed and its plan sent to the Washington State Department of Ecology within 15 days following the notification. An outline of such a plan is presented in Table 4.1.

The quality assessment program will include 1) number, location, and depth of wells in the monitoring network; 2) sampling and analytical methods used; 3) evaluation procedures; and 4) a schedule for implementation. The quality assessment program will also provide an investigative approach to determine rate and extent of migration of hazardous waste or hazardous constituents in the ground water and their concentrations. As soon as technically feasible, these determinations will be made and a report of the findings sent to the Washington State Department of Ecology. Table 4.2 provides a schedule for reports and notifications.

Table 4.1. Sample Ground-Water Quality Assessment Plan Outline.

- Introduction
- Ground-Water Quality Assessment Program
  - Investigatory Approach
  - Hydrogeology of the Site
  - Description of the Background Monitoring Network
  - Existing Data and Evaluation
  - Ground-Water Quality Assessment Monitoring System
  - Ground-Water Quality Sampling Schedule
  - Water-Table Monitoring
  - Sampling and Analytical Methods
  - Quality Assurance
  - Quality Control
    - United States Testing Company, Incorporated, Internal Quality Control
    - External Quality Control
  - Data Evaluation Procedures
- References
- Appendices

Table 4.2. Reports and Notifications.

Submittal	Submittal Period
Required whether or not the facility might be affecting ground water	
1. First year of sampling only: Concentrations of interim primary drinking water standards, identifying those that exceed the limits listed in Table 3.2	Quarterly reports
Concentration and statistical analyses of ground-water contamination indicator parameters, noting significant differences in upgradient wells	Annually, by March 30 of following year
Results of ground-water surface elevation evaluation and description of response if appropriate	Annually, by March 30 of following year
Required if the facility might be affecting ground water	
2. Notification to EPA and Washington State Department of Ecology that the facility might be affecting ground water	Within 7 days of confirmation of a statistical difference over background
Submittal of ground-water assessment plan to EPA and Washington State Department of Ecology	Within 15 days of the above notification
Submittal of a written report on assessment of ground-water quality, including concentrations of hazardous waste constituents and their rate and extent of migration, to EPA and Washington State Department of Ecology	Within 15 days of first determination (as soon as technically feasible)
Results of the ground-water quality assessment program	Annually, by March 30 of following year, until closure of the facility

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APPENDIX A

WASTE INFORMATION DATA SYSTEM SUMMARY REPORTS

APPENDIX A

WASTE INFORMATION DATA SYSTEM SUMMARY REPORTS

General waste facility information for facilities located in the vicinity of the S-10 facility are contained in this appendix. This information was obtained from the Waste Information Data System (WIDS), which is operated and maintained by Westinghouse Hanford. The facilities included in this appendix are

216-S-5 Crib
216-S-6 Crib
216-S-11 Pond
216-S-16 Pond
216-S-17 Pond
216-U-10 Pond

Waste Information Data System
General Summary Report
January 10, 1990

SITE NAME: 216-S-5
ALIAS NAMES: 216-S-5 Cavern #1, 216-S-6 Crib
216-S-9 Crib

SITE TYPE: Crib
WASTE CATEGORY: Mixed Waste

OPERABLE UNIT: 200-RO-1
REGULATORY AUTHORITY: Undefined

STATUS: Inactive, Pre-1980
SERVICE DATES: From 1954 to 1957

COORDINATES: N32740 W77000 (center of crib)
LOCATION: 200 West Area, 3,000 ft southwest of 207-S Retention Basin in the vicinity of 216-S-6, -10, -11, and -17.

REFERENCE DRAWINGS: H-2-5962, H-2-5963, H-2-2594

SITE AREA: 44,100.00 square feet

ELEVATIONS and DEPTHS:

Ground:	651.00 feet above MSL
Water Table:	180.00 feet below grade
Site Depth:	15.00 feet below grade

WASTE VOLUME RECEIVED: 4,100,000,000 liters
CONTAMINATED SOIL VOLUME: 13,000 cubic meters
OVERBURDEN SOIL VOLUME: 12,000 cubic meters

SITE DESCRIPTIONS:
Crib, gravel filled, 210-ft by 210-ft bottom surface. The side slope is 1.5:1. The crib contains ~16,333 cu yd of gravel fill. Two lengths of 30-in.-diameter, perforated, corrugated metal pipe form a cross with dimensions of 180 ft by 190 ft. The ends of the pipe are sealed with 1/4-in. plate covers. The plates are perforated.

WASTE DESCRIPTION:
From 3/54 to 3/57, the site received process vessel cooling water and steam condensate from 202-S. The site was deactivated in 3/57, when the top of the crib began to cave in. The waste is acidic.

SITE NAME: 216-S-5

COMMENTS:

The site was deactivated by valving out and locking the pipeline to the crib. The effluent was rerouted to the 216-S-6 Crib and 216-S-16 Pond. The 216-S-5 Crib (originally called an underground swamp) was built as a replacement for the grossly contaminated 216-S-17 Pond. Its function was to receive process cooling water and steam condensate from the 202-S Building.

See the physical files for historical excerpts from the REDOX radiation monitoring monthly reports on this site.

Wells W26-1, W26-3, W26-4, and W26-5 monitor this crib. The radionuclides are held high in the sediment beneath the crib. Breakthrough to groundwater has not occurred at this site.

RELEASE POTENTIAL:

This unit was used as a percolation crib.

ASSOCIATED STRUCTURES:

Two lengths of 30-in.-diameter perforated corrugated metal.
1/4-in.-diameter plate cover perforated on the pipe ends.
24-in. V.C.P. waste supply line to the crib.
Test well (299-W26-1) with an 8-in. casing, 100 ft 11 in. deep.
Two 4-in. SCH 40 perforated pipe liquid test wells, 13 ft deep.

8/09/89

Waste Information Data System
Radionuclide Inventory
(In Curies)

Sheet 3 of 5

These Values Are Decayed Thru: 12/31/88

Site Name: 216-S-5

H-3:		Ru-103:		Th-232:	
C-14:		Ru-106:	.00000	U-233:	
Na-22:		Sn-113:		U-234:	
Mn-54:		Sb-125:		U-235:	
Co-58:		I-129:		U-238:	
Fe-59:		Cs-134:		Np-237:	
Co-60:		Cs-137:	27.00000	Pu-238:	
Ni-63:		Ce-141:		Pu-239:	
Kr-85:		Ce-144:		Pu-240:	
Sr-90:	55.40000	Pr-144:		Pu-241:	
Y-91:		Pm-147:		Pu-242:	
Nb-95:		Eu-152:		Am-241:	
Zr-95:		Eu-154:		Am-243:	
Tc-99:		Eu-155:		Cm-245:	

Inventory Total U:		Total Reported Alpha:	35.60000
Inventory Total Pu:		Total Reported Beta:	163.00000
Site Reported Total:		Total Reported Gamma:	
Total Volume Disposed:	4100000000	Last Updated:	July 30, 1987

8/09/89

Waste Information Data System
Hazardous Chemical Inventory
(In Kilograms)

Summary Date: 7/01/86

Site Name: 216-S-5

INORGANICS

Ammonium Carbonate:		Ferrocyanide:	
Flouride:		Potassium:	
Nitrite:		Nitrate:	100.00000
Ammonium Nitrate:		Aluminum Nitrate:	
Ferric Nitrate:		Calcium Nitrate:	
Nitric Acid:		Magnesium Nitrate:	
Sodium:		Phosphate:	
Sodium Dichromate:		Sodium Aluminate:	
Sodium Silicate:		Sodium Hydroxide:	
Sulfuric Acid:		Sulfate:	
Sulfamic Acid:		Sodium Sulfamate:	
Copper Sulfate:		Potassium Borate:	
Mercury:		Chromium (VI):	
Cadmium (II):		Lead (II):	
Uranium:		Nickel (II):	
Zinc (II):			

ORGANICS

CCL4:		Hexone:	
MIK:		Trichloroethylene:	
DBP:		TBP:	

TOTAL VOLUME: 4100000000 (in liters)

8/09/89 Surveillance and Stabilization Data

SITE NAME: 216-S-5

Surveillance Schedule:	Annual	Area Posted:	Surface Contamination
Surveillance Date:	8/84	Area Fenced:	Yes
Present Vegitation (in % coverage):		Cave-in Potential:	None
Grasses:	1%	Exsisting Cave-ins:	None
Deeprooted:	1%		
None:	98%		

Results of Survey:
ID posts are incorrectly labeled. The site is posted as 216-S-6 Crib. Contaminated sagebrush in the center of the crib have readings to 1,000 ct/min.

Corrective Actions:
ID posts should be changed to reflect the proper site name. This area should be given strong consideration for stabilization to prevent recontamination of 216-S-17 and the surrounding area.

Area Stabilized:

Bladding or Backfill:

Biological Barriers:

Species Seeded:

Associated Structures:

Number of Concrete Posts:

Waste Information Data System
General Summary Report
January 10, 1990

SITE NAME: 216-S-6
ALIAS NAMES: 216-S-6 Cavern #2, 216-S-5 Crib
216-S-13 Crib

SITE TYPE: Crib
WASTE CATEGORY: Mixed Waste

OPERABLE UNIT: 200-RO-1
REGULATORY AUTHORITY: Undefined

STATUS: Inactive, Pre-1980
SERVICE DATES: From 1964 to 1972

COORDINATES: N33250 W77850 (center of crib)
LOCATION: 200 West Area, 3,648 ft southwest of the 202-S Building, 2,375 ft south of Tenth Street, in the vicinity of 216-S-5, -10, -11, and -17.

REFERENCE DRAWINGS: H-2-2594, H-2-2595, H-2-2596, H-2-44511 #8 & #16

SITE AREA: 44,100.00 square feet

ELEVATIONS and DEPTHS:

Ground:	651.00	feet above MSL
Water Table:	180.00	feet below grade
Site Depth:	15.00	feet below grade

WASTE VOLUME RECEIVED: 4,470,000,000 liters
CONTAMINATED SOIL VOLUME: 13,000 cubic meters
OVERBURDEN SOIL VOLUME: 12,000 cubic meters

SITE DESCRIPTIONS:
Crib, 210 by 210-ft bottom dimensions. The crib is filled with ~116,333 cu yd of gravel fill. Waste lines are ~7 ft below the surface. The risers are ~2 ft below the surface. The surface of the crib is ~10 ft below the surrounding ground surface.

WASTE DESCRIPTION:
From 11/64 to 6/67, the site received the process vessel cooling water and steam condensate from the 202-S Building. From 6/67 to 7/67, production operations were shut down and the 202-S Building put on standby. From 7/67 to 7/72, the site received the steam condensate from the D-12 and D-14 waste concentrators in the 202-S Building. The site was retired in 7/72. The waste is low salt and neutral/basic.

SITE NAME: 216-S-6

COMMENTS:

This crib was constructed as part of the segregation project for the segregation of high potential from low potential radioactive contaminated condensates and cooling water. The high potential was sent to the 216-S-6 Crib and the low potential to the 216-S-5 Crib. The 216-S-6 Crib was first used in November 1954. The crib has not been used since July 1972. See the physical file for excerpts from the REDOX radiation monitoring monthly report.

RELEASE POTENTIAL:

This unit was used as a percolation crib.

ASSOCIATED STRUCTURES:

The main wasteline, 10-gauge CMP, running through the middle of the crib, 210 ft long.

12 perforated corrugated metal pipes, 12 in. diameter, that spread waste liquid over gravel. Each pipe is 100 ft long with a riser at each end.

8/09/89

Waste Information Data System
Radionuclide Inventory
(In Curies)

These Values Are Decayed Thru: 12/31/88

Site Name: 216-S-6

H-3:		Ru-103:		Th-232:	
C-14:		Ru-106:	.00001	U-233:	
Na-22:		Sn-113:		U-234:	
Mn-54:		Sb-125:		U-235:	
Co-58:		I-129:		U-238:	
Fe-59:		Cs-134:		Np-237:	
Co-60:		Cs-137:	118.00000	Pu-238:	
Ni-63:		Ce-141:		Pu-239:	
Kr-85:		Ce-144:		Pu-240:	
Sr-90:	209.00000	Pr-144:		Pu-241:	
Y-91:		Pm-147:		Pu-242:	
Nb-95:		Eu-152:		Am-241:	
Zr-95:		Eu-154:		Am-243:	
Tc-99:		Eu-155:		Cm-245:	

Inventory Total U:		Total Reported Alpha:	29.00000
Inventory Total Pu:		Total Reported Beta:	645.00000
Site Reported Total:		Total Reported Gamma:	
Total Volume Disposed:	4470000000	Last Updated:	July 30, 1987

8/09/89

Waste Information Data System
Hazardous Chemical Inventory
(In Kilograms)

Summary Date: 7/01/86

Site Name: 216-S-6

INORGANICS

Ammonium Carbonate:		Ferrocyanide:	
Flouride:		Potassium:	
Nitrite:		Nitrate:	140.00000
Ammonium Nitrate:		Aluminum Nitrate:	
Ferric Nitrate:		Calcium Nitrate:	
Nitric Acid:		Magnesium Nitrate:	
Sodium:		Phosphate:	
Sodium Dichromate:		Sodium Aluminate:	
Sodium Silicate:		Sodium Hydroxide:	
Sulfuric Acid:		Sulfate:	
Sulfamic Acid:		Sodium Sulfamate:	
Copper Sulfate:		Potassium Borate:	
Mercury:		Chromium (VI):	
Cadmium (II):		Lead (II):	
Uranium:		Nickel (II):	
Zinc (II):			

ORGANICS

CCL4:		Hexone:	
MIK:		Trichloroethylene:	
DBP:		TBP:	

TOTAL VOLUME: 4470000000 (in liters)

8/09/89 Surveillance and Stabilization Data

SITE NAME: 216-S-6

Surveillance Schedule: Annual
Surveillance Date: 8/84
Present Vegitation (in % coverage):
Grasses: 90%
Deeprooted: 1%
None: 9%

Area Posted: Surface Contamination
Area Fenced: Yes
Cave-in Potential: None
Exsisting Cave-ins: None

Results of Survey:
2,000 to 200,000 dis/min on the surface and on live and dead rabbit bush.
Recommend removing the vegetation and clean the area.

Corrective Actions:
The decontamination is in progress.
The estimated completion date for the clean up is 9/30/89

Area Stabilized:

Bladding or Backfill:

Biological Barriers:

Species Seeded:

Associated Structures:

Number of Concrete Posts:

Waste Information Data System
General Summary Report
January 10, 1990

SITE NAME: 216-S-11
ALIAS NAMES: 202-S Chemical Sump #2 and Chemical Sewer Trench
216-S-11 Swamp

SITE TYPE: Pond
WASTE CATEGORY: Mixed Waste

OPERABLE UNIT: 200-RO-1
REGULATORY AUTHORITY: Undefined

STATUS: Inactive, Pre-1980
SERVICE DATES: From 1954 to 1965

COORDINATES: N32450 W76725 (center of #1), N32000 W76900 (center of #2)
LOCATION: 200 West Area, beginning 3,135 ft southwest of 202-S, southeast of the lower end of the 216-S-10 Ditch.

REFERENCE DRAWINGS: H-2-44510, H-2-34762, H-3-57210

SITE AREA: 65,340.00 square feet

ELEVATIONS and DEPTHS:

Ground:	651.00	feet above MSL
Water Table:	180.00	feet below grade
Site Depth:		feet below grade

WASTE VOLUME RECEIVED: 2,230,000,000 liters
CONTAMINATED SOIL VOLUME: 2,100 cubic meters
OVERBURDEN SOIL VOLUME: 5,700 cubic meters

SITE DESCRIPTIONS:
Pond covering 1.5 acres.

WASTE DESCRIPTION:
From 5/54 to 8/65, the site received the waste from air conditioning and drains in 202-S and the chemical sewer waste from 202-S via the 216-S-10 Ditch.
In 8/65, earth dammed the 216-S-10 Ditch to the S-11 Pond, diverting all building effluent to the 216-S-10 Pond.

SITE NAME: 216-S-11

COMMENTS:

The 216-S-11 Pond inventory is a portion of the reported inventory for the 216-S-11 site (see the physical file).

The two 216-S-11 small ponds were dug in May 1954 to give additional leaching surface for the disposal of water from the 216-S-10 Ditch. The pond inlets from the ditch were cut somewhat above the level of the 216-S-10 Ditch bottom so that the 216-S-11 Ponds would become dry whenever the water in the 216-S-10 Ditch receded and would fill again when the 216-S-10 Ditch water level became high enough to overflow into the ponds. The south pond was covered in the summer of 1976. See the physical file for history of the site.

The 216-S-11 south pond area is presently being used as a root depth penetration study site. It is free from radioactive contamination.

RELEASE POTENTIAL:

This unit was used as a percolation pond.

8/09/89

Waste Information Data System
Radionuclide Inventory
(In Curies)

Sheet 3 of 3

These Values Are Decayed Thru: 12/31/88

Site Name: 216-S-11

H-3:		Ru-103:		Th-232:	
C-14:		Ru-106:	.58300	U-233:	
Na-22:		Sn-113:		U-234:	
Mn-54:		Sb-125:		U-235:	
Co-58:		I-129:		U-238:	
Fe-59:		Cs-134:		Np-237:	
Co-60:		Cs-137:	.83900	Pu-238:	
Ni-63:		Ce-141:		Pu-239:	
Kr-85:		Ce-144:		Pu-240:	
Sr-90:	.83400	Pr-144:		Pu-241:	
Y-91:		Pm-147:		Pu-242:	
Nb-95:		Eu-152:		Am-241:	
Zr-95:		Eu-154:		Am-243:	
Tc-99:		Eu-155:		Cm-245:	

Inventory Total U:		Total Reported Alpha:	.00553
Inventory Total Pu:		Total Reported Beta:	2.27000
Site Reported Total:		Total Reported Gamma:	
Total Volume Disposed:	2230000000	Last Updated:	July 30, 1987

Waste Information Data System
General Summary Report
August 30, 1989

SITE NAME: 216-S-16P
ALIAS NAMES: 202-S Swamp and Ditch, 202-S Swamp #1 and Ditch, 202-Swamp No. 1
REDOX Pond #2, Redox Pond No. 2

SITE TYPE: Pond
WASTE CATEGORY: Mixed Waste

OPERABLE UNIT: 200-RO-1
REGULATORY AUTHORITY: Undefined

STATUS: Inactive, Pre-1980
SERVICE DATES: From 1957 to 1975

COORDINATES: N32250 W81600 (center of pond complex)
LOCATION: 200 West Area, beginning ~7,000 ft southwest of the 202-S Building.

REFERENCE DRAWINGS: H-2-44510, H-2-34762, H-3-57210, H-2-72904

SITE AREA: 1,350,360.00 square feet

ELEVATIONS and DEPTHS:

Ground	:	651.00 feet above MSL
Water Table	:	180.00 feet below grade
Site Depth	:	3.00 feet below grade

WASTE VOLUME RECEIVED:	40,700,000,000 liters
CONTAMINATED SOIL VOLUME:	43,000 cubic meters
OVERBURDEN SOIL VOLUME:	77,000 cubic meters

SITE DESCRIPTION:

Pond consisting of four smaller ponds separated by dikes and a leach trench 10 ft deep and 1,100 ft long, extending east from Pond #2. The #4 pond was never used. The total area was ~31 acres. In 1975, this area was leveled and backfilled. A number of test plots were sealed with asphalt and a root toxin was applied.

WASTE DESCRIPTION:

From 1/57 to 6/67, the site received process cooling water and steam condensate from the 202-S Building.
From 6/67 to 7/67, production operations were shut down and 202-S put on standby.
From 7/67 to 2/75, the site received condenser and vessel cooling water from concentrator boil-down operations in the 202-S Building.
The site was retired in 2/75.

COMMENTS:

The site was deactivated by backfilling over. The #1 Pond was also treated with a root toxin and sealed with asphalt.
See the physical files for information on the history and stabilization of this site.

SITE NAME: 216-S-16P

RELEASE POTENTIAL:
This unit was used as a percolation pond.

ASSOCIATED STRUCTURES:
Six 6-in.-diameter by 10-ft-long pipes (radionuclide monitoring wells).
Two 2-in.-diameter by 5-ft-long pipes (moisture wells).
All pipes are SCH 40 black iron.

8/30/89

Waste Information Data System
Radionuclide Inventory
(In Curies)

Sheet 3 of 4

These Values Are Decayed Thru: 6/30/88
Site Name: 216-S-16P

H-3:		Ru-103:		Th-232:	
C-14:		Ru-106:	.00002	U-233:	
Na-22:		Sn-113:		U-234:	
Mn-54:		Sb-125:		U-235:	
Co-58:		I-129:		U-238:	1.06000
Fe-59:		Cs-134:		Np-237:	
Co-60:	.53900	Cs-137:	31.40000	Pu-238:	
Ni-63:		Ce-141:		Pu-239:	21.00000
Kr-85:		Ce-144:		Pu-240:	5.67000
Sr-90:	47.40000	Pr-144:		Pu-241:	
Y-91:		Pm-147:		Pu-242:	
Nb-95:		Eu-152:		Am-241:	
Zr-95:		Eu-154:		Am-243:	
Tc-99:		Eu-155:		Cm-245:	

Inventory Total U:		Total Reported Alpha:	22.60000
Inventory Total Pu:		Total Reported Beta:	156.00000
Site Reported Total:		Total Reported Gamma:	
Total Volume Disposed:	40700000000	Last Updated:	July 30, 1987

8/30/89

Waste Information Data System
Hazardous Chemical Inventory
(In Kilograms)

Summary Date: 7/01/86

Site Name: 216-S-16P

INORGANICS

Ammonium Carbonate:
Flouride:
Nitrite:
Ammonium Nitrate:
Ferric Nitrate:
Nitric Acid:
Sodium:
Sodium Dichromate:
Sodium Silicate:
Sulfuric Acid:
Sulfamic Acid:
Copper Sulfate:
Mercury:
Cadmium (II):
Uranium:
Zinc (II):

Ferrocyanide:
Potassium:
Nitrate:
Aluminum Nitrate:
Calcium Nitrate:
Magnesium Nitrate:
Phosphate:
Sodium Aluminate:
Sodium Hydroxide:
Sulfate:
Sodium Sulfamate:
Potassium Borate:
Chromium (VI):
Lead (II):
Nickel (II):

ORGANICS

CCL4:
MIK:
DBP:

Hexone:
Trichloroethylene:
TBP:

TOTAL VOLUME: 40700000000 (in liters)

Waste Information Data System
General Summary Report
January 10, 1990

SITE NAME: 216-S-17
ALIAS NAMES: 202-S Swamp, 202-S REDOX Swamp
REDOX Swamp, 216-S-1, 216-S-1 REDOX Pond No. 1

SITE TYPE: Pond
WASTE CATEGORY: Mixed Waste
OPERABLE UNIT: 200-RO-1
REGULATORY AUTHORITY: Undefined

STATUS: Inactive, Pre-1980
SERVICE DATES: From 1951 to 1954

COORDINATES: N32000 W78000 (center of pond)
LOCATION: 200 West Area, 3,743 ft southwest of 202-S Building and 2,983 ft south of Thirteenth Street.

REFERENCE DRAWINGS: H-2-44510, H-2-34762, H-3-57210, H-2-74444, H-2-72904

SITE AREA: 917,764.00 square feet

ELEVATIONS and DEPTHS:

Ground:	651.00	feet above MSL
Water Table:	180.00	feet below grade
Site Depth:	10.00	feet below grade

WASTE VOLUME RECEIVED:	6,430,000,000	liters
CONTAMINATED SOIL VOLUME:	24,000	cubic meters
OVERBURDEN SOIL VOLUME:	85,000	cubic meters

SITE DESCRIPTIONS:
Pond covering 21 acres.

WASTE DESCRIPTION:
From 10/51 to 1/53, the site received the process cooling water and steam condensate from the 202-S Building.
From 1/53 to 4/54, the site received the 202-S effluent and the overflow from 216-U-10 Pond via the 216-U-9 Ditch.
The site was retired in 4/54, when the radionuclide inventory in the sediments exceeded prescribed limits.

COMMENTS:
The site was deactivated by plugging the pipeline to the pond north of the 216-S-5 Crib and covering the pond area with clean earth. The effluents were rerouted to the 216-S-5 Crib. The overflow from the 216-U-10 Pond was discontinued.
See the physical file for history on this site.

RELEASE POTENTIAL:
This unit was used as a percolation pond.

8/09/89

Waste Information Data System
Radionuclide Inventory
(In Curies)

These Values Are Decayed Thru: 12/31/88

Site Name: 216-S-17

H-3:		Ru-103:		Th-232:	
C-14:		Ru-106:	.00000	U-233:	
Na-22:		Sn-113:		U-234:	
Mn-54:		Sb-125:		U-235:	
Co-58:		I-129:		U-238:	
Fe-59:		Cs-134:		Np-237:	
Co-60:		Cs-137:	13.00000	Pu-238:	
Ni-63:		Ce-141:		Pu-239:	
Kr-85:		Ce-144:		Pu-240:	
Sr-90:	16.28000	Pr-144:		Pu-241:	
Y-91:		Pm-147:		Pu-242:	
Nb-95:		Eu-152:		Am-241:	
Zr-95:		Eu-154:		Am-243:	
Tc-99:		Eu-155:		Cm-245:	

Inventory Total U:		Total Reported Alpha:	.18400
Inventory Total Pu:		Total Reported Beta:	57.60000
Site Reported Total:		Total Reported Gamma:	
Total Volume Disposed:	6430000000	Last Updated:	July 30, 1987

8/09/89

Waste Information Data System
Hazardous Chemical Inventory
(In Kilograms)

Summary Date: 7/01/86

Site Name: 216-S-17

INORGANICS

Ammonium Carbonate:		Ferrocyanide:	
Flouride:		Potassium:	
Nitrite:		Nitrate:	140.00000
Ammonium Nitrate:		Aluminum Nitrate:	
Ferric Nitrate:		Calcium Nitrate:	
Nitric Acid:		Magnesium Nitrate:	
Sodium:		Phosphate:	
Sodium Dichromate:		Sodium Aluminate:	
Sodium Silicate:		Sodium Hydroxide:	
Sulfuric Acid:		Sulfate:	
Sulfamic Acid:		Sodium Sulfamate:	
Copper Sulfate:		Potassium Borate:	
Mercury:		Chromium (VI):	
Cadmium (II):		Lead (II):	
Uranium:		Nickel (II):	
Zinc (II):			

ORGANICS

CCL4:		Hexone:	
MIK:		Trichloroethylene:	
DBP:		TBP:	

TOTAL VOLUME: 6430000000 (in liters)

8/09/89 Surveillance and Stabilization Data

SITE NAME: 216-S-17

Surveillance Schedule: Quarterly
Surveillance Date: 3/86
Present Vegitation (in % coverage):
Grasses: 80%
Deeprooted:
None: 20%

Area Posted: Underground Radioactive Matl.
Area Fenced: None
Cave-in Potential: None
Exsisting Cave-ins: None

Results of Survey:
Contaminated tumbleweed fragment found in one area.

Corrective Actions:
The area will be cleaned in April.

Area Stabilized:
41.7 acres

Bladding or Backfill:
2 ft of soil

Biological Barriers:
Not Available

Species Seeded:
Wintergraze; Crested, Siberian, Thickspike Wheatgrasses

Associated Structures:
Not Available

Number of Concrete Posts:
Not Available

Stabilation Complition Date: 3/01/84

Waste Information Data System
General Summary Report
August 30, 1989

SITE NAME: 216-U-10
ALIAS NAMES: 231 Swamp, U Swamp
216-U-1

SITE TYPE: Pond
WASTE CATEGORY: TRU-Contaminated Soil Site/Mixed
OPERABLE UNIT: 200-UP-1
REGULATORY AUTHORITY: Undefined

STATUS: Inactive
SERVICE DATES: From 1944 to 1985

COORDINATES: N36500 W77500 (center of pond)
LOCATION: 200 West Area, 3,720 ft southwest of the 221-U Building.

REFERENCE DRAWINGS: H-2-32527, H-2-36824, H-2-34762, H-2-39579, H-2-2430, H-2-1495, H-2-5962
H-2-5963

SITE AREA: 958,313.00 square feet

ELEVATIONS and DEPTHS:
Ground : 660.00 feet above MSL
Water Table: 180.00 feet below grade
Site Depth : feet below grade

WASTE VOLUME RECEIVED: 164,000,000,000 liters
CONTAMINATED SOIL VOLUME: 190 cubic meters
OVERBURDEN SOIL VOLUME: cubic meters

SITE DESCRIPTION:
Pond, backfilled over and stabilized, now covering 30 acres. The stabilized area also includes UN-216-E-14, UN-216-E-15, UN-216-E-16, and UN-216-E-17.

WASTE DESCRIPTION:
From 7/44 to 4/80, the site received the following effluents at various times: 284-W Powerhouse process cooling water; steam condensate from 231-Z and 234-T buildings via 216-Z-1 Ditch; wastewater from 2723-W mask cleaning station and 2724-W laundry via 216-U-14 Ditch; chemical sewer wastes from 221-U Building; cooling water from 224-U Building, 231-Z laboratory wastes via 216-Z-1 Ditch; 241-U-110 Tank condenser water via 216-U-14 Ditch; vacuum pump seal water from 291-Z Building; Hanford laboratory waste and PNL operations waste from 231-Z via 216-U-14 Ditch; and 242-S Evaporator steam condensate via 216-U-14 Ditch. From 4/80 to 9/81, the site received the same as above minus wastes from 231-Z, 234-5-Z, 2723-W, 2724-W wastes and 242-S Evaporator steam condensate. From 9/81 to 7/84, the site received the same as above minus 221-U, 224-U, and 271-U. From 7/84 to 2/85, the site only received 242-S cooling water. The site was stabilized in 3/85.

SITE NAME: 216-U-10

COMMENTS:
See the physical files for radionuclide inventories discharged to U Pond and information on leach trenches dug for overflow water from 216-U-10.

ENVIRONMENTAL MONITORING:
Radiological surveys of the surface are performed semiannually.

RELEASE POTENTIAL:
This unit was used as a percolation pond.

8/30/89 | Waste Information Data System | Sheet 3 of 4

Radionuclide Inventory
(In Curies)

These Values Are Decayed Thru: 12/31/88
Site Name: 216-U-10

H-3:	2.23700	Ru-103:		Th-232:	
C-14:		Ru-106:	.00006	U-233:	
Na-22:		Sn-113:		U-234:	
Mn-54:		Sb-125:		U-235:	
Co-58:		I-129:		U-238:	
Fe-59:		Cs-134:		Np-237:	
Co-60:		Cs-137:	11.20000	Pu-238:	
Ni-63:		Ce-141:		Pu-239:	.01770
Kr-85:		Ce-144:		Pu-240:	
Sr-90:	11.29000	Pr-144:		Pu-241:	
Y-91:		Pm-147:		Pu-242:	
Nb-95:		Eu-152:		Am-241:	.47731
Zr-95:		Eu-154:		Am-243:	
Tc-99:		Eu-155:		Cm-245:	

Inventory Total U:		Total Reported Alpha:	505.00000
Inventory Total Pu:		Total Reported Beta:	45.30000
Site Reported Total:		Total Reported Gamma:	
Total Volume Disposed:	164000000000	Last Updated:	July 30, 1987

8/30/89

Sheet 4 of 4

Waste Information Data System
Hazardous Chemical Inventory
(In Kilograms)

Summary Date: 7/01/86

Site Name: 216-U-10

INORGANICS

Ammonium Carbonate:	0.00000	Ferrocyanide:	
Flouride:		Potassium:	
Nitrite:		Nitrate:	100000.00000
Ammonium Nitrate:		Aluminum Nitrate:	
Ferric Nitrate:		Calcium Nitrate:	
Nitric Acid:		Magnesium Nitrate:	
Sodium:		Phosphate:	
Sodium Dichromate:		Sodium Aluminate:	
Sodium Silicate:		Sodium Hydroxide:	
Sulfuric Acid:		Sulfate:	
Sulfamic Acid:		Sodium Sulfamate:	
Copper Sulfate:		Potassium Borate:	
Mercury:		Chromium (VI):	
Cadmium (II):		Lead (II):	
Uranium:		Nickel (II):	
Zinc (II):			

ORGANICS

CCL4:		Hexone:	
MIK:		Trichloroethylene:	
DBP:		TBP:	

TOTAL VOLUME: 164000000000 (in liters)

APPENDIX B

GEOLOGIC AND WELL CONSTRUCTION DIAGRAMS FOR EXISTING WELLS

APPENDIX B

GEOLOGIC AND WELL CONSTRUCTION DIAGRAMS FOR EXISTING WELLS

Geologic and well construction diagrams from eight existing monitoring wells in the vicinity of the 216-S-10 Ditch and Pond are included in this appendix. These logs were compiled from data obtained from wells drilled by U.S. Department of Energy contractors. The lithologic and well construction information was derived using driller's logs, Bjornstad (1984), ROCSAN (sieve and calcium carbonate) data, and borehole geophysical logs. Information in this appendix was used, where possible, to substantiate site-specific geologic information and evaluate the construction of existing wells. The following logs were reviewed and are included in this appendix:

Well	Date Completed	Location (Hanford Coordinates)
299-W22-17	8/56	N35534/W75082
299-W23-11	11/72	N35560/W76725
299-W26-3	6/54	N33006/W77269
299-W26-6	3/83	N32635/W76895
699-29-78	11/62	N29379/W77727
699-32-72	7/57	N32482/W72041
699-32-77	5/51	N31812/W77032
699-35-78A	8/50	N35478/W78190

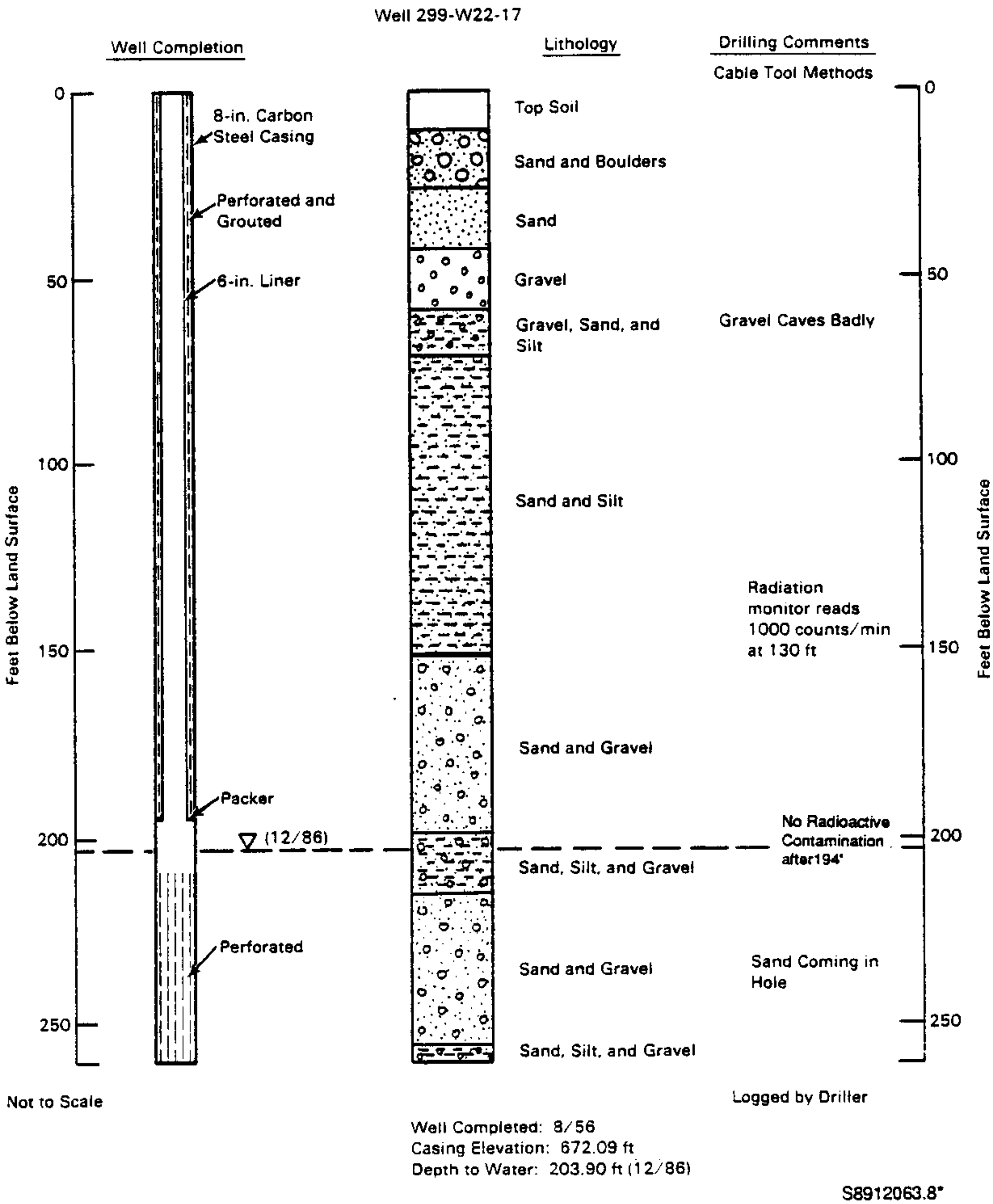

Figure B.1. Well 299-W22-17.

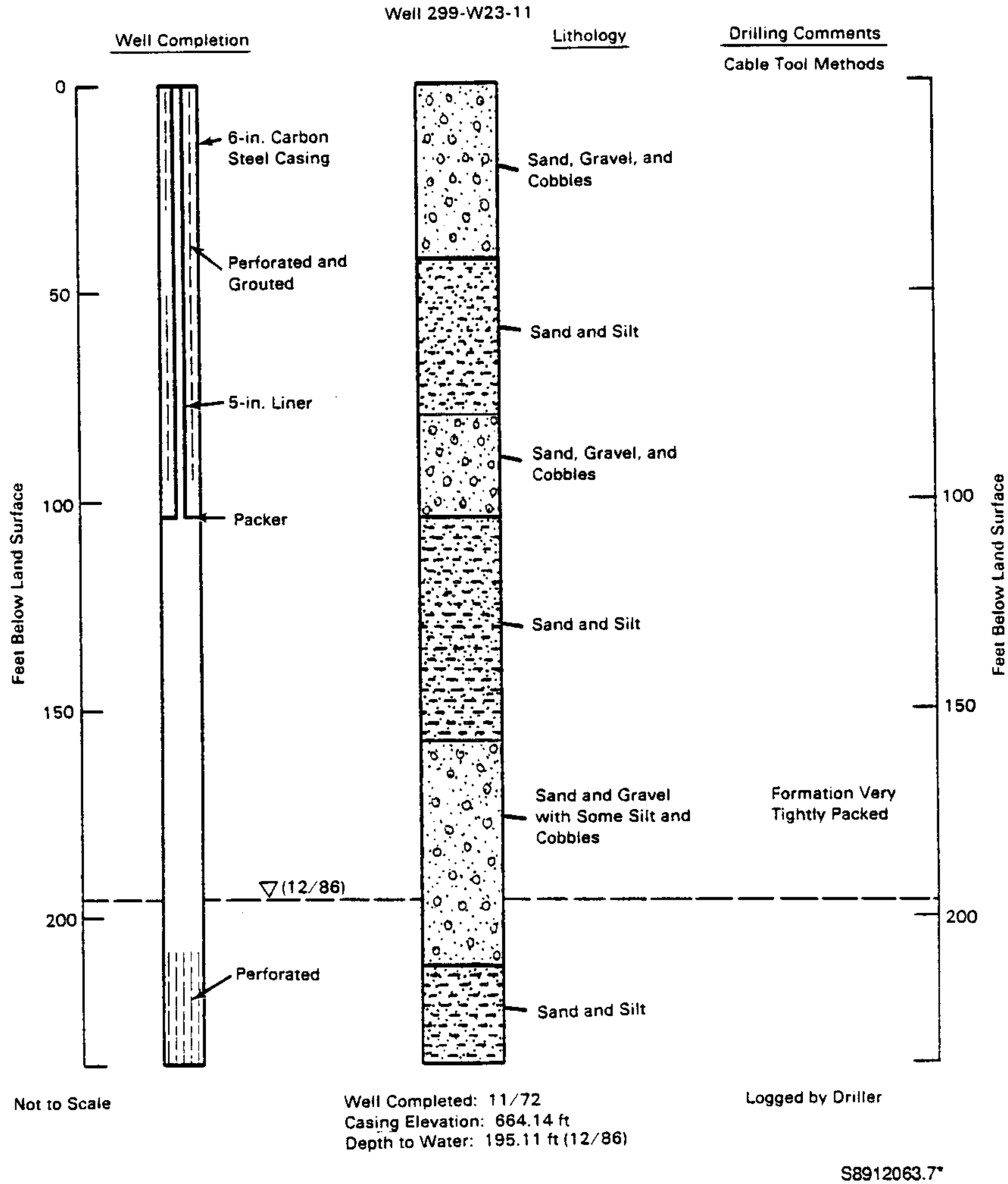

Figure B.2. Well 299-W23-11

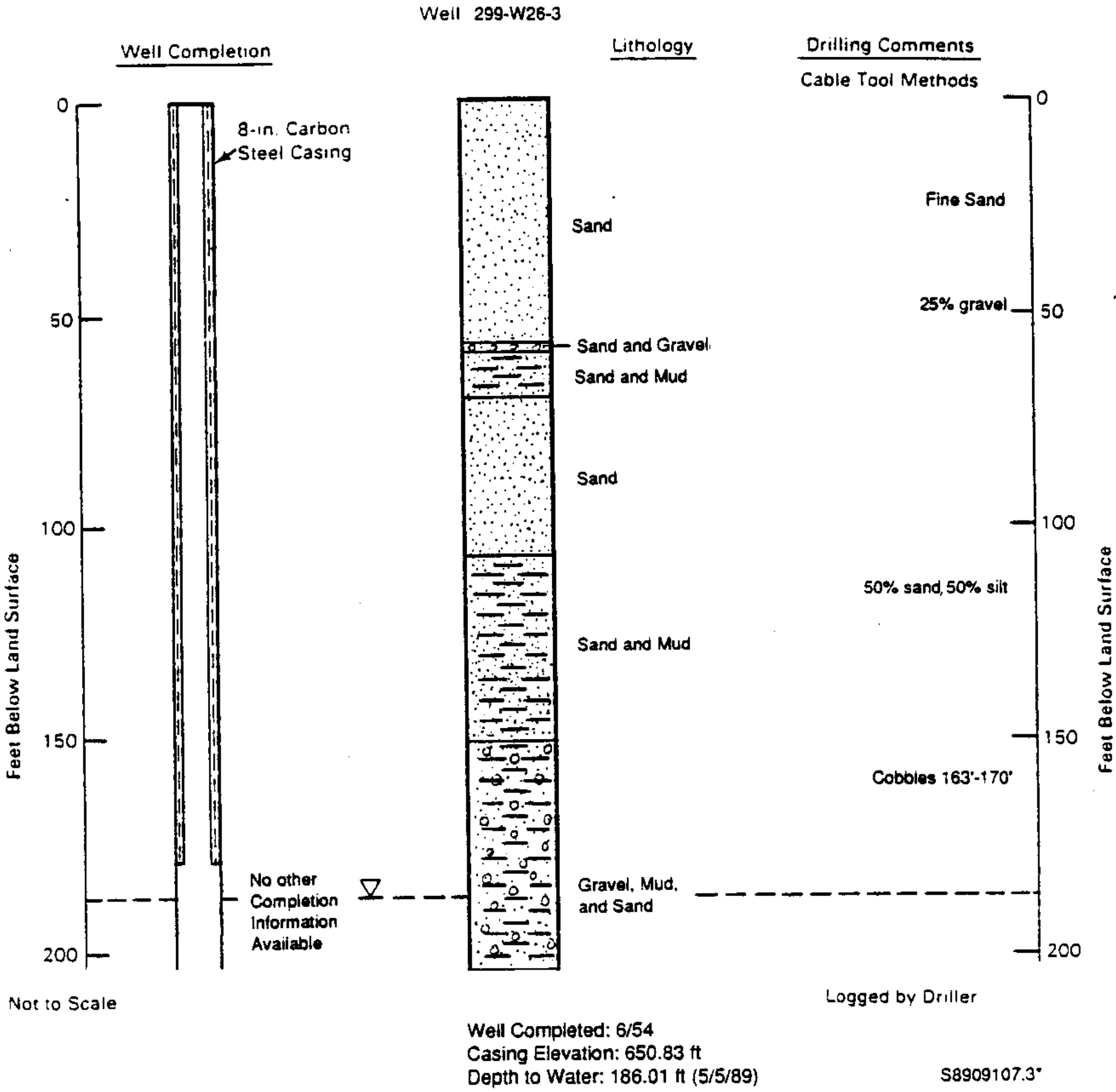

Figure B.3. Well 299-W26-3.

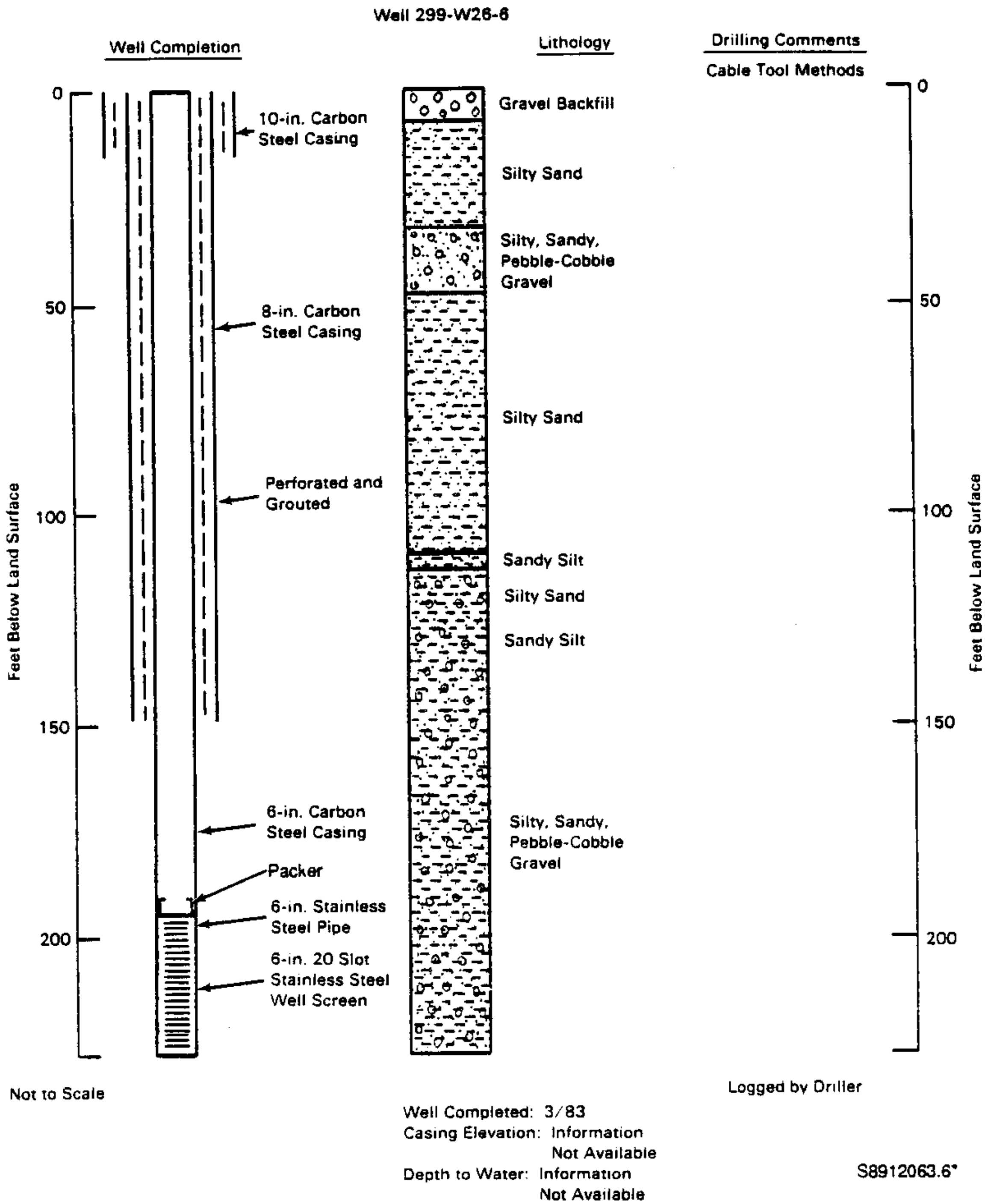

Figure B.4. Well 299-W26-6.

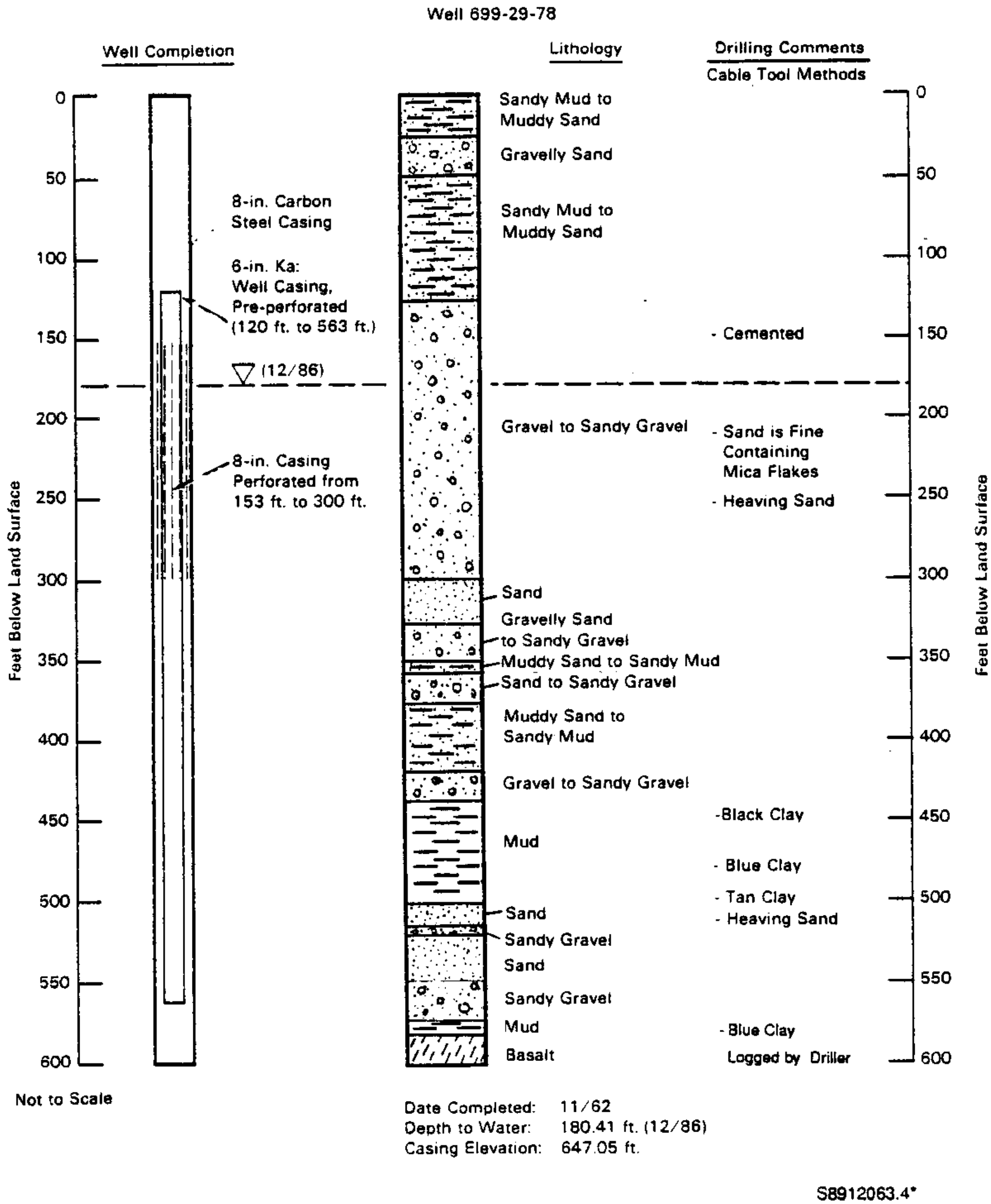

Figure B.5. Well 699-29-78.

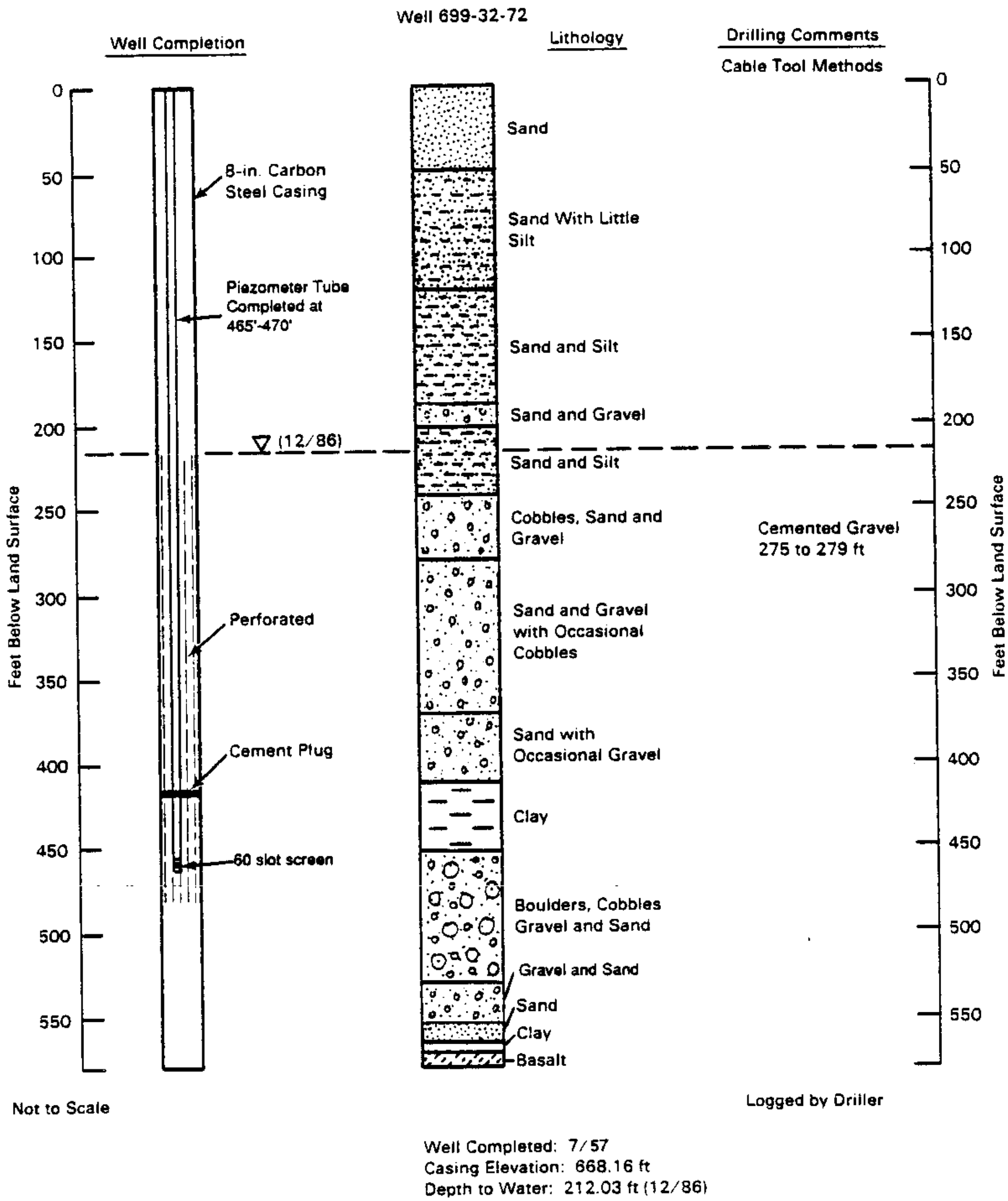

Figure B.6. Well 699-32-72.

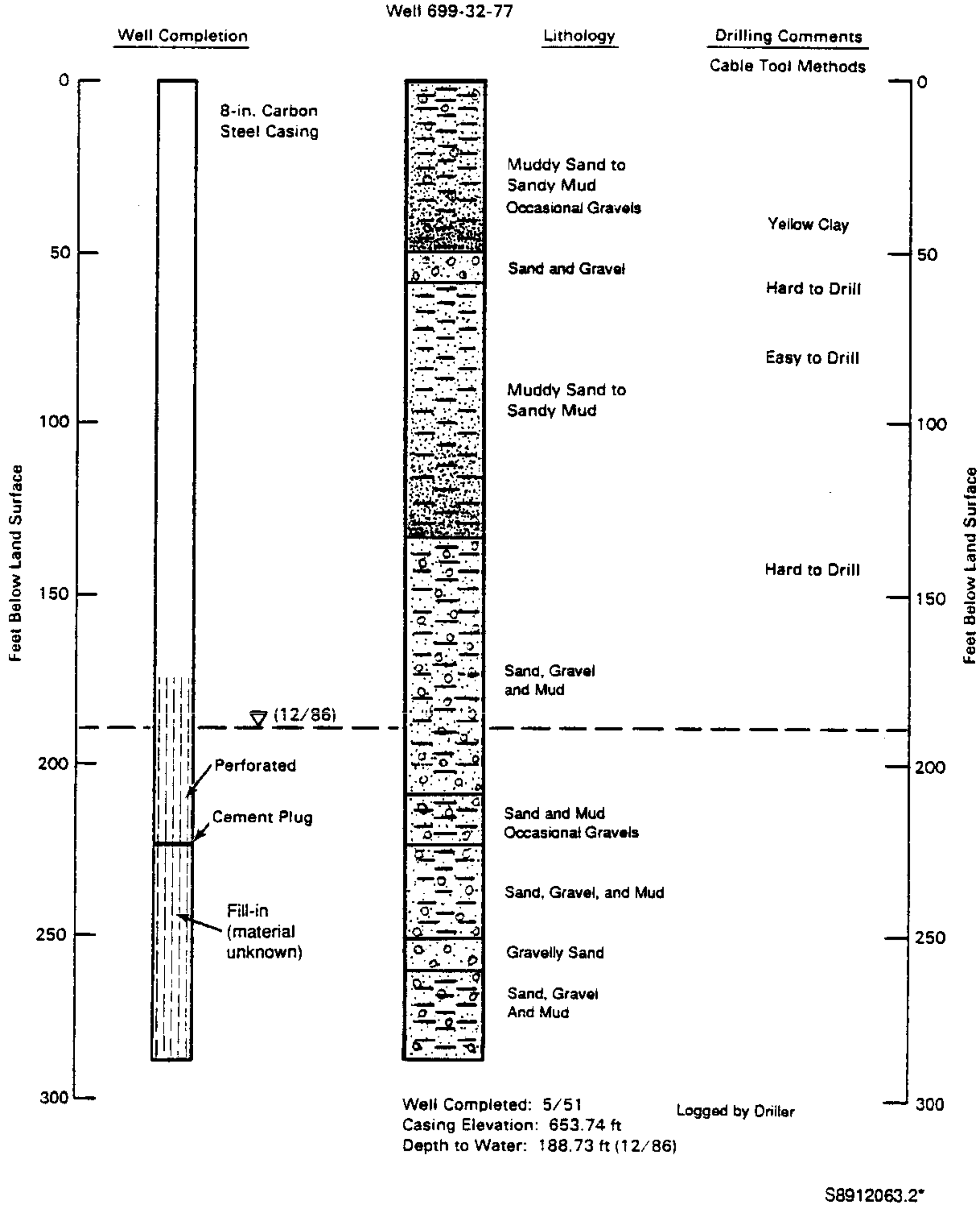

Figure B.7. Well 699-32-77.

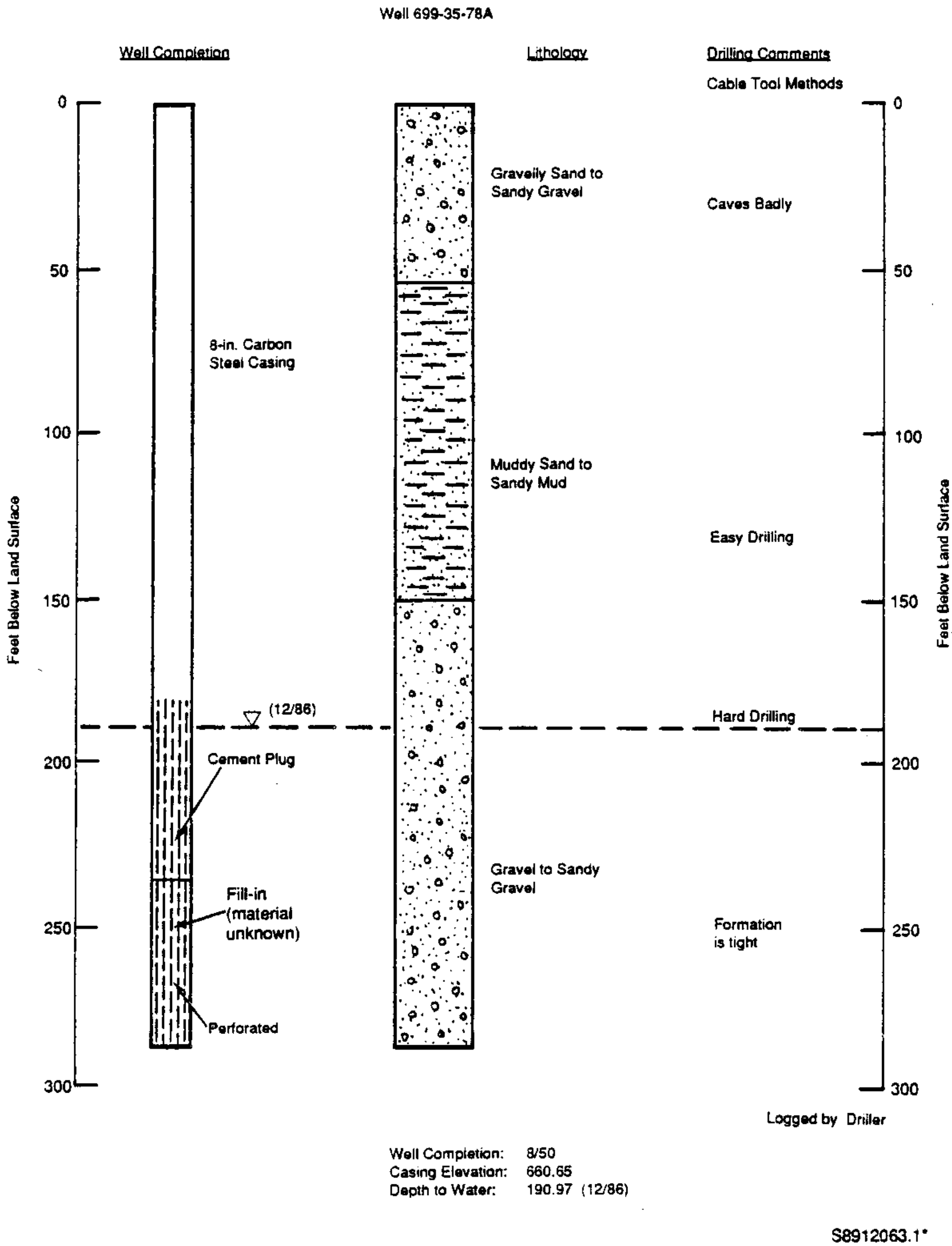

Figure B.8. Well 699-35-78A.

APPENDIX C

WATER-LEVEL DATA

APPENDIX C

WATER-LEVEL DATA

This appendix provides water-level data for 11 wells near the vicinity of 216-U-10 pond and 216-S-10 Ditch and Pond. These data were taken from the Hanford Ground Water Data Base. Data from the following wells are presented:

299-W18-15	Table C.1 and Figure C.1
299-W19-15	Table C.2 and Figure C.2
299-W22-17	Table C.3 and Figure C.3
299-W22-22	Table C.4 and Figure C.4
299-W23-4	Table C.5 and Figure C.5
299-W26-3	Table C.6 and Figure C.6
699-29-78	Table C.7 and Figure C.7
699-32-72	Table C.8 and Figure C.8
699-32-77	Table C.9 and Figure C.9
699-35-78A	Table C.10 and Figure C.10
699-37-82A	Table C.11 and Figure C.11

Hydrographs plotted from these data are also presented (Figures C.1 - C.11). Head data are listed in two columns labeled "computed head" and "hydraulic head". Computed head values were determined by the Hanford Ground Water Data Base programs from stored water-level and casing elevation data. Hydraulic head values were hand calculated using water-level and casing elevation data, then stored in the Hanford Ground Water Data Base.

Table C.1. Water Level Data for Well 299-W18-15 (Sheet 1 of 2).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
2-W18-15	6/08/84	0.00	480.42	660.76
2-W18-15	6/08/84	480.42	0.00	660.76
2-W18-15	6/11/84	0.00	485.71	660.76
2-W18-15	6/11/84	485.71	0.00	660.76
2-W18-15	6/18/84	0.00	485.68	660.76
2-W18-15	6/18/84	485.68	0.00	660.76
2-W18-15	6/25/84	0.00	485.69	660.76
2-W18-15	6/25/84	485.69	0.00	660.76
2-W18-15	7/10/84	0.00	485.61	660.76
2-W18-15	7/10/84	485.61	0.00	660.76
2-W18-15	7/22/84	0.00	485.59	660.76
2-W18-15	7/23/84	485.59	0.00	660.76
2-W18-15	8/06/84	485.39	0.00	660.76
2-W18-15	8/19/84	0.00	485.48	660.76
2-W18-15	8/20/84	485.48	0.00	660.76
2-W18-15	9/04/84	0.00	485.51	660.76
2-W18-15	9/05/84	485.51	0.00	660.76
2-W18-15	9/16/84	0.00	485.12	660.76
2-W18-15	9/17/84	485.12	0.00	660.76
2-W18-15	10/01/84	484.86	0.00	660.76
2-W18-15	10/17/84	484.78	0.00	660.76
2-W18-15	10/29/84	484.18	0.00	660.76
2-W18-15	11/19/84	484.03	0.00	660.76
2-W18-15	12/10/84	483.98	0.00	660.76
2-W18-15	12/27/84	483.63	0.00	660.76
2-W18-15	1/09/85	482.79	0.00	660.76
2-W18-15	1/23/85	482.54	0.00	660.76
2-W18-15	2/04/85	482.23	0.00	660.76
2-W18-15	2/19/85	482.46	0.00	660.76
2-W18-15	3/05/85	481.81	0.00	660.76
2-W18-15	4/02/85	481.20	0.00	660.76
2-W18-15	4/16/85	480.92	0.00	660.76
2-W18-15	5/02/85	480.81	0.00	660.76
2-W18-15	5/13/85	480.18	0.00	660.76
2-W18-15	5/27/85	479.97	0.00	660.76
2-W18-15	6/12/85	479.60	0.00	660.76
2-W18-15	6/26/85	479.25	0.00	660.76
2-W18-15	7/09/85	478.79	0.00	660.76
2-W18-15	8/05/85	478.04	0.00	660.76
2-W18-15	12/18/85	475.72	0.00	660.76
2-W18-15	12/08/86	472.14	0.00	660.76
2-W18-15	12/14/87	472.32	0.00	660.76

Table C.1. Water Level Data for Well 299-W18-15 (Sheet 2 of 2).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
2-W18-15	2/18/88	472.09	0.00	660.76
2-W18-15	3/03/88	472.48	0.00	660.76
2-W18-15	3/09/88	472.29	0.00	660.76
2-W18-15	3/23/88	472.41	0.00	660.76
2-W18-15	3/31/88	471.94	0.00	660.76
2-W18-15	8/17/88	471.26	0.00	660.76
2-W18-15	12/01/88	471.05	0.00	660.76
2-W18-15	12/30/88	471.56	0.00	660.76
2-W18-15	5/05/89	470.70	0.00	660.76
2-W18-15	6/19/89	470.69	0.00	660.76

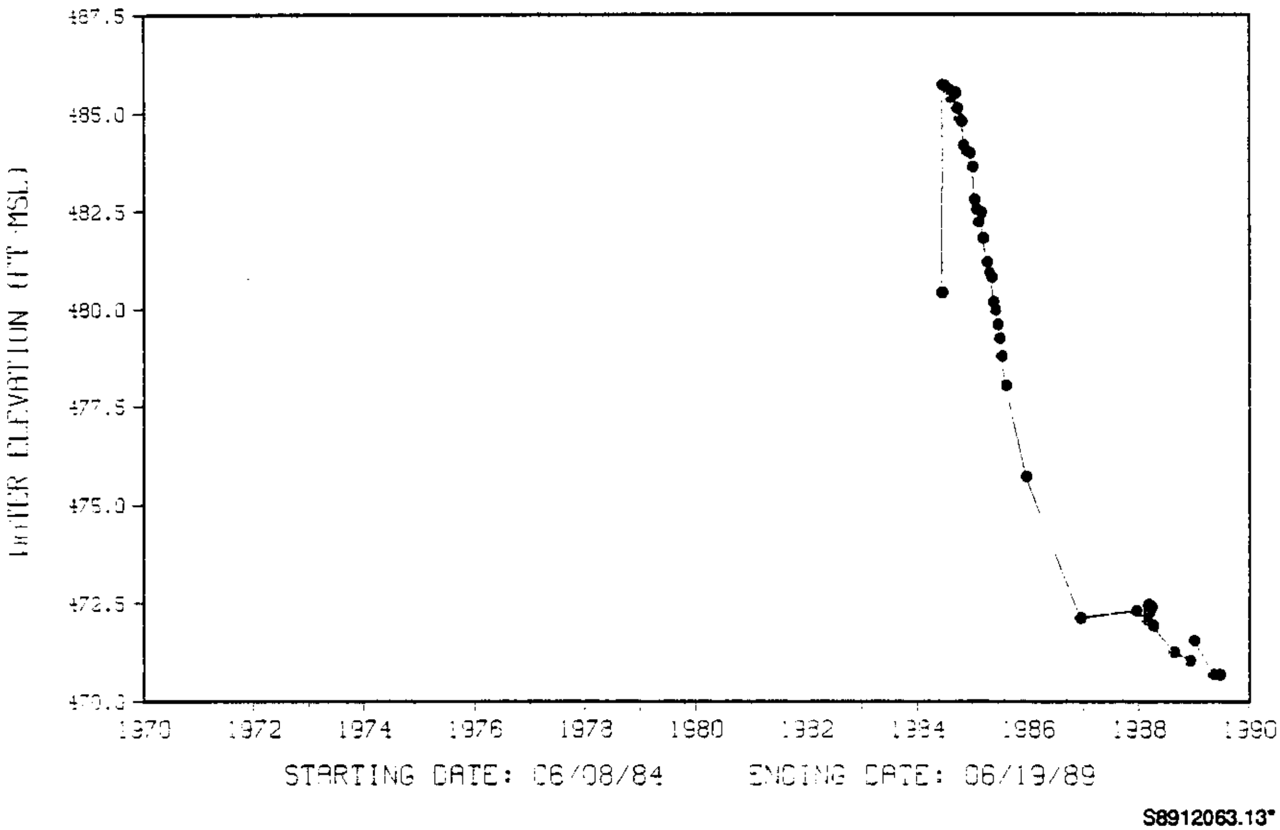

Figure C.1. Data for Well 299-W18-15.

Table C.2. Water Level Data for Well 299-W19-15.

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
2-W19-15	12/18/85	471.95	0.00	693.28
2-W19-15	12/10/86	469.98	0.00	693.28
2-W19-15	12/14/87	468.32	0.00	693.28
2-W19-15	8/17/88	0.00	0.00	693.28
2-W19-15	12/15/88	467.53	0.00	693.28
2-W19-15	5/05/89	466.90	0.00	693.28

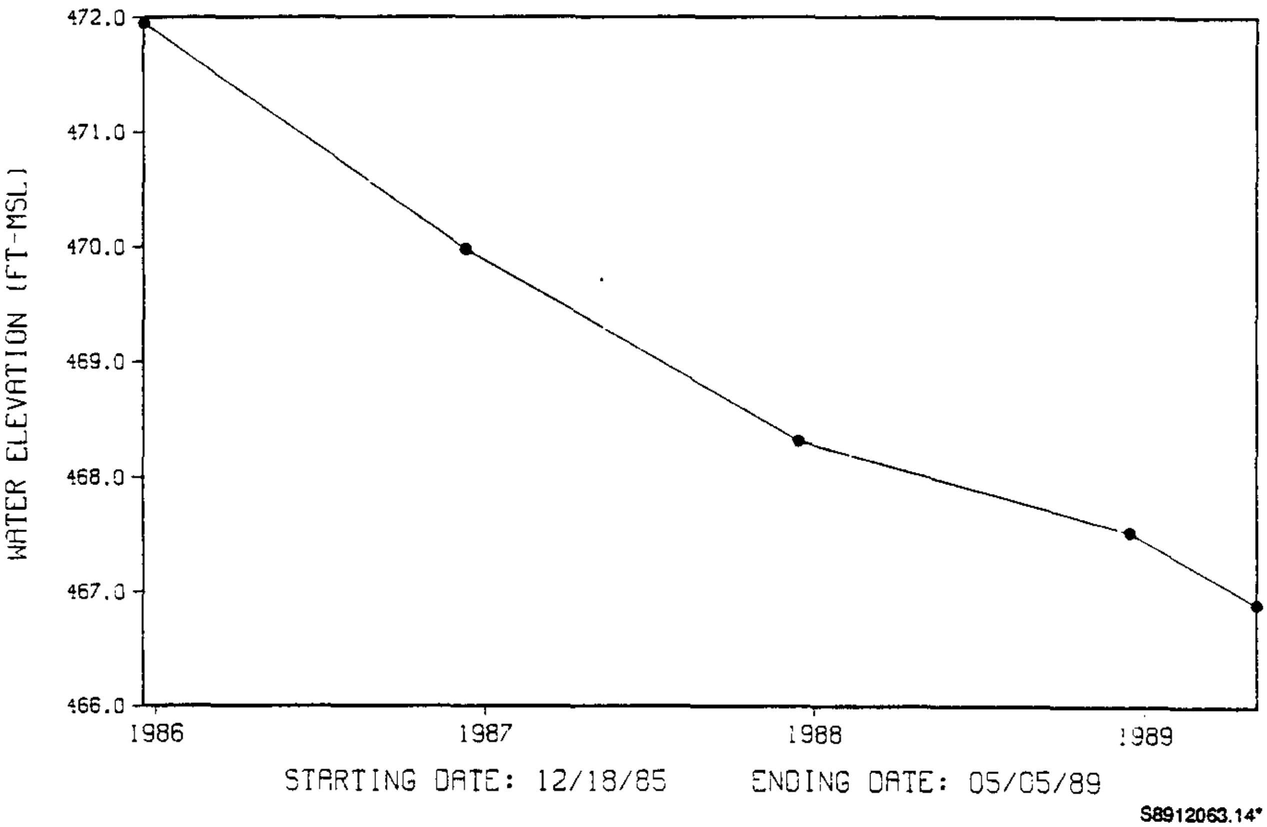

Figure C.2. Data for Well 299-W19-15.

Table C.3. Water Level Data for Well 299-W22-17.

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
2-W22-17	8/29/56	0.00	465.20	671.62
2-W22-17	1/08/75	0.00	473.52	671.62
2-W22-17	4/14/75	0.00	474.12	671.62
2-W22-17	7/07/75	0.00	474.20	671.62
2-W22-17	12/03/75	0.00	474.93	671.62
2-W22-17	6/15/76	0.00	475.02	671.62
2-W22-17	12/08/76	0.00	475.85	671.62
2-W22-17	7/01/77	0.00	475.65	671.62
2-W22-17	12/07/77	0.00	475.51	671.62
2-W22-17	6/01/78	0.00	475.77	671.62
2-W22-17	12/01/78	0.00	475.97	671.62
2-W22-17	12/01/79	0.00	475.14	671.62
2-W22-17	6/01/80	0.00	475.95	671.62
2-W22-17	12/01/80	0.00	474.40	671.62
2-W22-17	6/01/81	0.00	473.57	671.62
2-W22-17	12/01/81	0.00	472.25	671.62
2-W22-17	6/01/82	0.00	473.00	671.62
2-W22-17	6/01/83	0.00	474.08	671.62
2-W22-17	12/01/83	0.00	472.70	671.62
2-W22-17	6/01/84	0.00	475.03	671.62
2-W22-17	12/01/84	0.00	474.32	671.62
2-W22-17	6/20/85	471.93	0.00	671.62
2-W22-17	12/18/85	469.73	0.00	671.62
2-W22-17	12/29/86	467.72	0.00	671.62
2-W22-17	12/15/87	467.32	0.00	671.62
2-W22-17	5/05/89	465.74	0.00	671.62

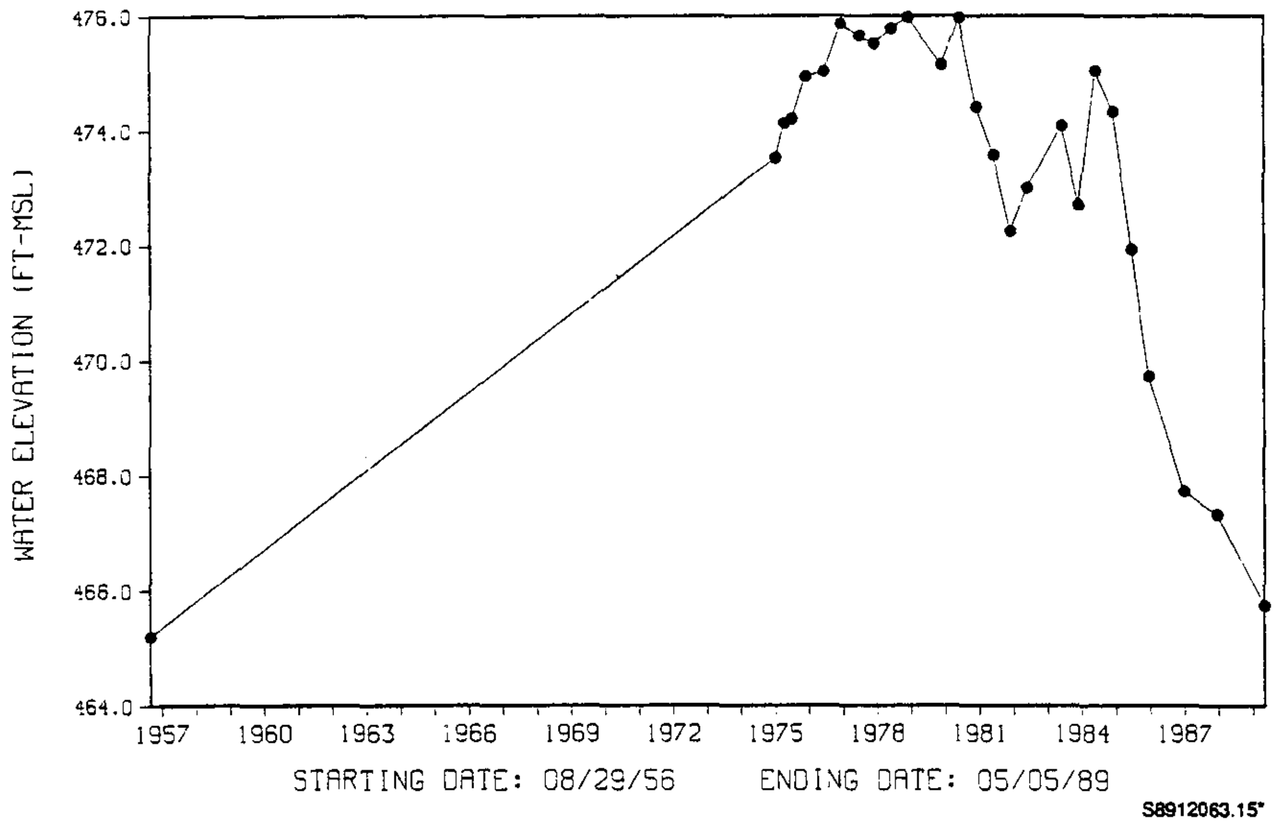

Figure C.3. Data for Well 299-W22-17.

Table C.4. Water Level Data for Well 299-W22-22.

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
2-W22-22	5/02/74	0.00	481.08	690.38
2-W22-22	7/15/74	0.00	462.94	690.38
2-W22-22	10/18/74	0.00	463.55	690.38
2-W22-22	1/08/75	0.00	464.22	690.38
2-W22-22	4/14/75	0.00	465.10	690.38
2-W22-22	7/07/75	0.00	465.03	690.38
2-W22-22	12/03/75	0.00	465.62	690.38
2-W22-22	6/15/76	0.00	466.04	690.38
2-W22-22	12/08/76	0.00	467.41	690.38
2-W22-22	7/01/77	0.00	467.97	690.38
2-W22-22	12/07/77	0.00	466.55	690.38
2-W22-22	6/01/78	0.00	467.00	690.38
2-W22-22	12/01/78	0.00	466.64	690.38
2-W22-22	12/01/79	0.00	466.55	690.38
2-W22-22	6/01/80	0.00	466.49	690.38
2-W22-22	12/01/80	0.00	465.94	690.38
2-W22-22	6/01/81	0.00	466.04	690.38
2-W22-22	12/01/81	0.00	465.01	690.38
2-W22-22	6/01/82	0.00	464.35	690.38
2-W22-22	12/01/82	0.00	464.34	690.38
2-W22-22	6/01/83	0.00	465.71	690.38
2-W22-22	12/01/83	0.00	464.43	690.38
2-W22-22	6/01/84	0.00	466.96	690.38
2-W22-22	12/01/84	0.00	467.09	690.38
2-W22-22	6/12/85	466.51	0.00	690.38
2-W22-22	12/17/85	464.67	0.00	690.38
2-W22-22	12/08/86	463.21	0.00	690.38
2-W22-22	12/14/87	462.17	0.00	690.38
2-W22-22	8/19/88	461.87	0.00	690.38
2-W22-22	12/20/88	462.33	0.00	690.38
2-W22-22	12/28/88	461.34	0.00	690.38
2-W22-22	5/05/89	461.33	0.00	690.38

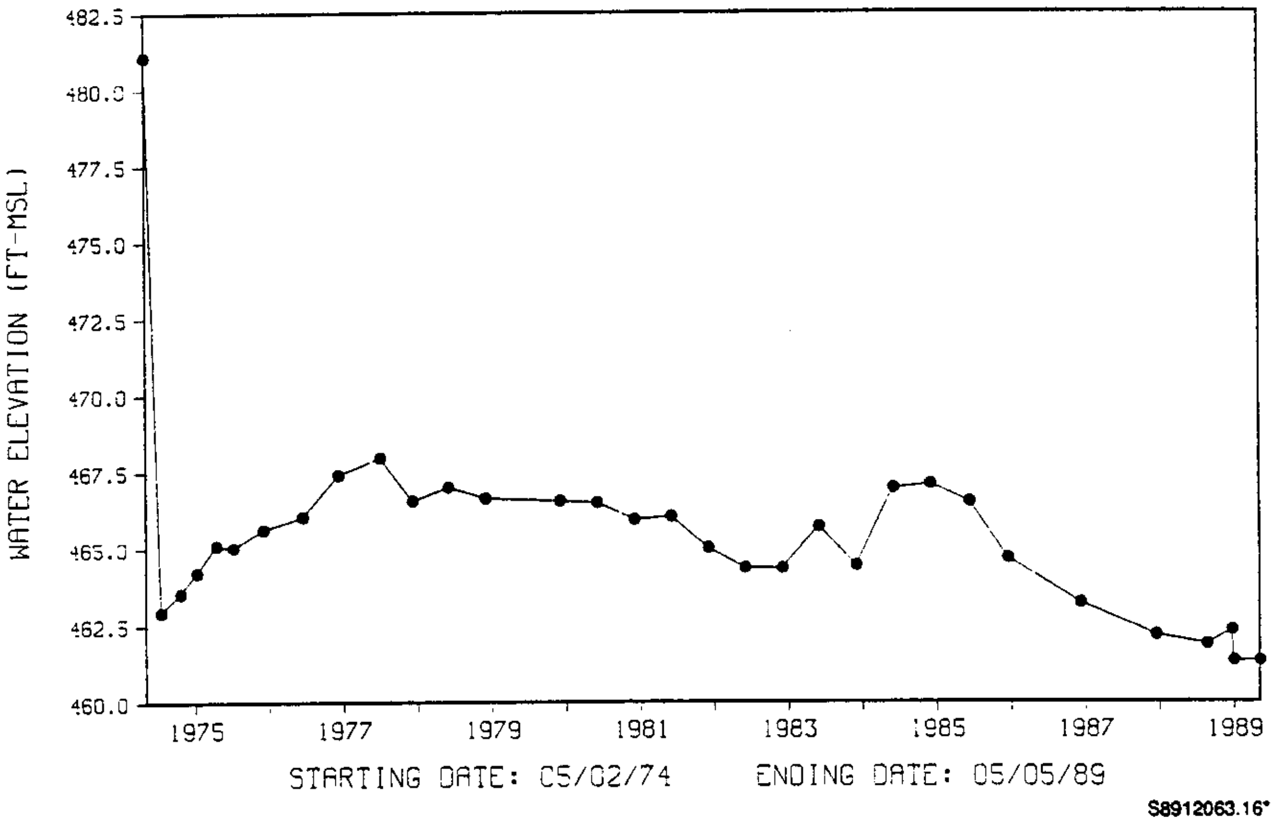

Figure C.4. Data for Well 299-W22-22.

Table C.5. Water Level Data for Well 299-W23-4 (Sheet 1 of 9).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
2-W23-4	8/27/65	0.00	478.75	662.82
2-W23-4	9/23/65	0.00	479.18	662.82
2-W23-4	10/20/65	0.00	479.31	662.82
2-W23-4	1/03/66	0.00	480.06	662.82
2-W23-4	3/04/66	0.00	479.93	662.82
2-W23-4	4/11/66	0.00	480.28	662.82
2-W23-4	5/19/66	0.00	480.36	662.82
2-W23-4	7/11/66	0.00	480.06	662.82
2-W23-4	7/12/66	0.00	480.08	662.82
2-W23-4	11/03/66	0.00	480.28	662.82
2-W23-4	12/28/66	0.00	481.38	662.82
2-W23-4	4/07/66	0.00	481.59	662.82
2-W23-4	10/20/67	0.00	480.50	662.82
2-W23-4	3/21/68	0.00	480.07	662.82
2-W23-4	4/28/69	0.00	480.57	662.82
2-W23-4	5/14/70	0.00	478.62	662.82
2-W23-4	9/14/71	0.00	476.18	662.82
2-W23-4	3/06/72	0.00	476.73	662.82
2-W23-4	7/06/72	0.00	475.73	662.82
2-W23-4	8/31/72	0.00	475.11	662.82
2-W23-4	1/04/73	0.00	474.69	662.82
2-W23-4	4/13/73	0.00	474.09	662.82
2-W23-4	5/02/74	0.00	477.04	662.82
2-W23-4	7/15/74	0.00	480.28	662.82
2-W23-4	10/18/74	0.00	481.62	662.82
2-W23-4	1/08/75	0.00	481.73	662.82
2-W23-4	4/14/75	0.00	481.98	662.82
2-W23-4	7/07/75	0.00	481.94	662.82
2-W23-4	12/03/75	0.00	482.63	662.82
2-W23-4	6/15/76	0.00	482.02	662.82
2-W23-4	12/08/76	0.00	483.56	662.82
2-W23-4	7/01/77	0.00	482.27	662.82
2-W23-4	12/07/77	0.00	482.28	662.82
2-W23-4	6/01/78	0.00	482.42	662.82
2-W23-4	12/01/78	0.00	482.09	662.82
2-W23-4	12/01/79	0.00	481.96	662.82
2-W23-4	6/01/80	0.00	480.47	662.82
2-W23-4	12/01/80	0.00	480.68	662.82
2-W23-4	6/01/81	0.00	479.61	662.82
2-W23-4	12/01/81	0.00	478.09	662.82
2-W23-4	6/01/82	0.00	479.45	662.82
2-W23-4	12/01/82	0.00	479.46	662.82
2-W23-4	12/15/82	480.10	0.00	662.82

Table C.5. Water Level Data for Well 299-W23-4 (Sheet 2 of 9).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
2-W23-4	6/01/83	0.00	480.61	662.82
2-W23-4	6/15/83	480.59	0.00	662.82
2-W23-4	12/01/83	0.00	479.39	662.82
2-W23-4	12/15/83	479.41	0.00	662.82
2-W23-4	6/01/84	0.00	481.89	662.82
2-W23-4	6/05/84	0.00	481.86	662.82
2-W23-4	6/05/84	481.86	0.00	662.82
2-W23-4	6/11/84	0.00	481.99	662.82
2-W23-4	6/11/8	481.99	0.00	662.82
2-W23-4	6/18/84	0.00	481.96	662.82
2-W23-4	6/18/84	481.96	0.00	662.82
2-W23-4	6/25/84	0.00	481.88	662.82
2-W23-4	6/25/84	481.88	0.00	662.82
2-W23-4	7/10/84	0.00	482.76	662.82
2-W23-4	7/10/84	482.76	0.00	662.82
2-W23-4	7/22/84	0.00	481.92	662.82
2-W23-4	7/23/84	481.92	0.00	662.82
2-W23-4	8/06/84	481.74	0.00	662.82
2-W23-4	8/19/84	0.00	481.87	662.82
2-W23-4	8/20/84	481.87	0.00	662.82
2-W23-4	9/04/84	0.00	481.96	662.82
2-W23-4	9/05/84	481.96	0.00	662.82
2-W23-4	9/16/84	0.00	481.59	662.82
2-W23-4	9/17/84	481.54	0.00	662.82
2-W23-4	10/01/84	481.31	0.00	662.82
2-W23-4	10/09/84	481.30	0.00	662.82
2-W23-4	10/10/84	481.56	0.00	662.82
2-W23-4	10/11/84	481.29	0.00	662.82
2-W23-4	10/12/84	481.14	0.00	662.82
2-W23-4	10/13/84	480.97	0.00	662.82
2-W23-4	10/14/84	481.04	0.00	662.82
2-W23-4	10/15/84	480.98	0.00	662.82
2-W23-4	10/16/84	481.32	0.00	662.82

Table C.5. Water Level Data for Well 299-W23-4 (Sheet 3 of 9).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
2-W23-4	10/17/84	481.30	0.00	662.82
2-W23-4	10/18/84	480.89	0.00	662.82
2-W23-4	10/19/84	481.10	0.00	662.82
2-W23-4	10/20/84	481.05	0.00	662.82
2-W23-4	10/21/84	480.93	0.00	662.82
2-W23-4	10/22/84	480.85	0.00	662.82
2-W23-4	10/23/84	480.90	0.00	662.82
2-W23-4	10/24/84	480.99	0.00	662.82
2-W23-4	10/25/84	481.47	0.00	662.82
2-W23-4	10/26/84	481.38	0.00	662.82
2-W23-4	10/27/84	480.90	0.00	662.82
2-W23-4	10/28/84	481.01	0.00	662.82
2-W23-4	10/29/84	480.67	0.00	662.82
2-W23-4	10/30/84	480.96	0.00	662.82
2-W23-4	10/31/84	480.47	0.00	662.82
2-W23-4	11/01/84	480.85	0.00	662.82
2-W23-4	11/02/84	481.58	0.00	662.82
2-W23-4	11/03/84	480.87	0.00	662.82
2-W23-4	11/04/84	480.45	0.00	662.82
2-W23-4	11/07/84	480.68	0.00	662.82
2-W23-4	11/08/84	480.84	0.00	662.82
2-W23-4	11/09/84	480.36	0.00	662.82
2-W23-4	11/10/84	480.81	0.00	662.82
2-W23-4	11/11/84	480.70	0.00	662.82
2-W23-4	11/20/84	480.53	0.00	662.82
2-W23-4	11/21/84	480.25	0.00	662.82
2-W23-4	12/01/84	0.00	480.10	662.82
2-W23-4	12/11/84	480.24	0.00	662.82
2-W23-4	12/12/84	480.55	0.00	662.82
2-W23-4	12/13/84	479.92	0.00	662.82
2-W23-4	12/18/84	479.60	0.00	662.82
2-W23-4	12/26/84	480.10	0.00	662.82
2-W23-4	12/27/84	480.22	0.00	662.82
2-W23-4	12/28/84	479.78	0.00	662.82
2-W23-4	12/29/84	479.68	0.00	662.82
2-W23-4	12/30/84	479.40	0.00	662.82
2-W23-4	1/02/85	479.45	0.00	662.82
2-W23-4	1/08/85	479.63	0.00	662.82
2-W23-4	1/15/85	479.34	0.00	662.82
2-W23-4	1/16/85	479.29	0.00	662.82
2-W23-4	1/17/85	479.47	0.00	662.82
2-W23-4	1/18/85	479.56	0.00	662.82
2-W23-4	1/19/85	479.40	0.00	662.82
2-W23-4	1/20/85	479.42	0.00	662.82

Table C.5. Water Level Data for Well 299-W23-4 (Sheet 4 of 9).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
2-W23-4	1/21/85	479.30	0.00	662.82
2-W23-4	1/22/85	479.24	0.00	662.82
2-W23-4	1/23/85	479.24	0.00	662.82
2-W23-4	1/24/85	479.19	0.00	662.82
2-W23-4	1/25/85	479.09	0.00	662.82
2-W23-4	1/29/85	478.99	0.00	662.82
2-W23-4	1/30/85	478.67	0.00	662.82
2-W23-4	1/31/85	478.77	0.00	662.82
2-W23-4	2/01/85	479.25	0.00	662.82
2-W23-4	2/02/85	478.85	0.00	662.82
2-W23-4	2/05/85	478.67	0.00	662.82
2-W23-4	2/06/85	478.56	0.00	662.82
2-W23-4	2/07/85	478.66	0.00	662.82
2-W23-4	2/08/85	478.58	0.00	662.82
2-W23-4	2/12/85	477.97	0.00	662.82
2-W23-4	2/13/85	477.89	0.00	662.82
2-W23-4	2/14/85	478.18	0.00	662.82
2-W23-4	2/15/85	478.21	0.00	662.82
2-W23-4	2/16/85	478.12	0.00	662.82
2-W23-4	2/17/85	478.04	0.00	662.82
2-W23-4	2/18/85	478.03	0.00	662.82
2-W23-4	2/19/85	478.40	0.00	662.82
2-W23-4	2/20/85	478.03	0.00	662.82
2-W23-4	2/21/85	477.94	0.00	662.82
2-W23-4	2/22/85	477.84	0.00	662.82
2-W23-4	2/23/85	477.77	0.00	662.82
2-W23-4	2/24/85	478.02	0.00	662.82
2-W23-4	2/25/85	477.57	0.00	662.82
2-W23-4	2/26/85	477.72	0.00	662.82
2-W23-4	2/27/85	477.69	0.00	662.82
2-W23-4	2/28/85	477.90	0.00	662.82
2-W23-4	3/01/85	477.84	0.00	662.82
2-W23-4	3/02/85	477.65	0.00	662.82
2-W23-4	3/03/85	477.63	0.00	662.82
2-W23-4	3/04/85	477.89	0.00	662.82
2-W23-4	3/05/85	477.62	0.00	662.82
2-W23-4	3/06/85	477.64	0.00	662.82
2-W23-4	3/07/85	477.39	0.00	662.82
2-W23-4	3/08/85	477.14	0.00	662.82
2-W23-4	3/09/85	477.40	0.00	662.82
2-W23-4	3/10/85	477.49	0.00	662.82
2-W23-4	3/11/85	477.35	0.00	662.82
2-W23-4	3/12/85	477.31	0.00	662.82

Table C.5. Water Level Data for Well 299-W23-4 (Sheet 5 of 9).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
2-W23-4	3/13/85	477.25	0.00	662.82
2-W23-4	3/14/85	477.39	0.00	662.82
2-W23-4	3/15/85	477.27	0.00	662.82
2-W23-4	3/16/85	477.31	0.00	662.82
2-W23-4	3/17/85	477.25	0.00	662.82
2-W23-4	3/18/85	477.22	0.00	662.82
2-W23-4	3/19/85	477.21	0.00	662.82
2-W23-4	3/20/85	477.17	0.00	662.82
2-W23-4	3/21/85	477.25	0.00	662.82
2-W23-4	3/26/85	477.52	0.00	662.82
2-W23-4	3/27/85	477.54	0.00	662.82
2-W23-4	3/28/85	477.01	0.00	662.82
2-W23-4	3/29/85	476.82	0.00	662.82
2-W23-4	3/30/85	477.04	0.00	662.82
2-W23-4	3/31/85	476.91	0.00	662.82
2-W23-4	4/01/85	476.96	0.00	662.82
2-W23-4	4/02/85	476.92	0.00	662.82
2-W23-4	4/03/85	476.98	0.00	662.82
2-W23-4	4/04/85	476.87	0.00	662.82
2-W23-4	4/05/85	476.89	0.00	662.82
2-W23-4	4/06/85	476.75	0.00	662.82
2-W23-4	4/07/85	476.72	0.00	662.82
2-W23-4	4/08/85	476.76	0.00	662.82
2-W23-4	4/09/85	476.86	0.00	662.82
2-W23-4	4/10/85	476.99	0.00	662.82
2-W23-4	4/11/85	476.68	0.00	662.82
2-W23-4	4/12/85	476.46	0.00	662.82
2-W23-4	4/13/85	476.69	0.00	662.82
2-W23-4	4/14/85	476.87	0.00	662.82
2-W23-4	4/15/85	476.97	0.00	662.82
2-W23-4	4/16/85	476.65	0.00	662.82
2-W23-4	4/17/85	476.56	0.00	662.82
2-W23-4	4/18/85	476.56	0.00	662.82
2-W23-4	4/20/85	476.57	0.00	662.82
2-W23-4	4/21/85	476.61	0.00	662.82
2-W23-4	4/24/85	476.15	0.00	662.82
2-W23-4	4/25/85	476.27	0.00	662.82
2-W23-4	4/26/85	476.41	0.00	662.82
2-W23-4	4/27/85	476.51	0.00	662.82
2-W23-4	4/28/85	476.37	0.00	662.82
2-W23-4	4/29/85	476.09	0.00	662.82
2-W23-4	4/30/85	476.22	0.00	662.82
2-W23-4	5/01/85	476.42	0.00	662.82

Table C.5. Water Level Data for Well 299-W23-4 (Sheet 6 of 9).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
2-W23-4	5/02/85	476.47	0.00	662.82
2-W23-4	5/03/85	476.21	0.00	662.82
2-W23-4	5/04/85	476.11	0.00	662.82
2-W23-4	5/05/85	476.25	0.00	662.82
2-W23-4	5/06/85	476.29	0.00	662.82
2-W23-4	5/07/85	476.17	0.00	662.82
2-W23-4	5/08/85	476.11	0.00	662.82
2-W23-4	5/09/85	476.11	0.00	662.82
2-W23-4	5/10/85	476.21	0.00	662.82
2-W23-4	5/11/85	475.93	0.00	662.82
2-W23-4	5/12/85	475.89	0.00	662.82
2-W23-4	5/13/85	475.98	0.00	662.82
2-W23-4	5/14/85	475.97	0.00	662.82
2-W23-4	5/15/85	475.92	0.00	662.82
2-W23-4	5/16/85	475.92	0.00	662.82
2-W23-4	5/17/85	475.92	0.00	662.82
2-W23-4	5/18/85	475.92	0.00	662.82
2-W23-4	5/19/85	475.92	0.00	662.82
2-W23-4	5/20/85	475.90	0.00	662.82
2-W23-4	5/21/85	475.77	0.00	662.82
2-W23-4	5/22/85	475.78	0.00	662.82
2-W23-4	5/23/85	475.78	0.00	662.82
2-W23-4	5/24/85	475.78	0.00	662.82
2-W23-4	5/25/85	475.78	0.00	662.82
2-W23-4	5/26/85	475.85	0.00	662.82
2-W23-4	5/27/85	475.84	0.00	662.82
2-W23-4	5/28/85	475.76	0.00	662.82
2-W23-4	5/29/85	475.76	0.00	662.82
2-W23-4	5/30/85	475.66	0.00	662.82
2-W23-4	5/31/85	475.69	0.00	662.82
2-W23-4	6/01/85	475.69	0.00	662.82
2-W23-4	6/02/85	475.59	0.00	662.82
2-W23-4	6/03/85	475.59	0.00	662.82
2-W23-4	6/04/85	475.62	0.00	662.82
2-W23-4	6/05/85	475.65	0.00	662.82
2-W23-4	6/06/85	475.65	0.00	662.82
2-W23-4	6/07/85	475.67	0.00	662.82
2-W23-4	6/08/85	475.26	0.00	662.82
2-W23-4	6/09/85	475.46	0.00	662.82
2-W23-4	6/10/85	475.46	0.00	662.82
2-W23-4	6/11/85	475.50	0.00	662.82
2-W23-4	6/11/85	475.50	0.00	662.82
2-W23-4	6/12/85	475.61	0.00	662.82

Table C.5. Water Level Data for Well 299-W23-4 (Sheet 7 of 9).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
2-W23-4	6/13/85	475.53	0.00	662.82
2-W23-4	6/14/85	475.53	0.00	662.82
2-W23-4	6/15/85	475.42	0.00	662.82
2-W23-4	6/16/85	475.30	0.00	662.82
2-W23-4	6/17/85	475.37	0.00	662.82
2-W23-4	6/18/85	475.45	0.00	662.82
2-W23-4	6/19/85	475.53	0.00	662.82
2-W23-4	6/20/85	475.39	0.00	662.82
2-W23-4	6/21/85	475.25	0.00	662.82
2-W23-4	6/22/85	475.25	0.00	662.82
2-W23-4	6/23/85	475.17	0.00	662.82
2-W23-4	6/24/85	475.13	0.00	662.82
2-W23-4	6/25/85	475.13	0.00	662.82
2-W23-4	6/26/85	475.15	0.00	662.82
2-W23-4	6/27/85	475.15	0.00	662.82
2-W23-4	6/28/85	475.16	0.00	662.82
2-W23-4	6/29/85	475.32	0.00	662.82
2-W23-4	6/30/85	475.00	0.00	662.82
2-W23-4	7/01/85	475.05	0.00	662.82
2-W23-4	7/02/85	475.13	0.00	662.82
2-W23-4	7/03/85	475.13	0.00	662.82
2-W23-4	7/04/85	475.17	0.00	662.82
2-W23-4	7/05/85	475.02	0.00	662.82
2-W23-4	7/06/85	475.06	0.00	662.82
2-W23-4	7/07/85	475.07	0.00	662.82
2-W23-4	7/08/85	474.99	0.00	662.82
2-W23-4	7/09/85	475.03	0.00	662.82
2-W23-4	7/10/85	474.97	0.00	662.82
2-W23-4	7/11/85	474.98	0.00	662.82
2-W23-4	7/12/85	474.99	0.00	662.82
2-W23-4	7/13/85	474.90	0.00	662.82
2-W23-4	7/14/85	474.94	0.00	662.82
2-W23-4	7/15/85	474.94	0.00	662.82
2-W23-4	7/16/85	474.95	0.00	662.82
2-W23-4	7/17/85	474.87	0.00	662.82
2-W23-4	7/18/85	474.82	0.00	662.82
2-W23-4	7/19/85	474.84	0.00	662.82
2-W23-4	7/20/85	474.86	0.00	662.82
2-W23-4	7/21/85	474.87	0.00	662.82
2-W23-4	7/22/85	474.85	0.00	662.82
2-W23-4	7/23/85	474.75	0.00	662.82
2-W23-4	7/25/85	474.60	0.00	662.82
2-W23-4	7/26/85	474.60	0.00	662.82

Table C.5. Water Level Data for Well 299-W23-4 (Sheet 8 of 9).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
2-W23-4	7/27/85	474.60	0.00	662.82
2-W23-4	7/28/85	474.61	0.00	662.82
2-W23-4	7/29/85	474.63	0.00	662.82
2-W23-4	7/30/85	474.63	0.00	662.82
2-W23-4	7/31/85	474.40	0.00	662.82
2-W23-4	8/01/85	474.50	0.00	662.82
2-W23-4	8/02/85	474.47	0.00	662.82
2-W23-4	8/03/85	474.52	0.00	662.82
2-W23-4	8/04/85	474.62	0.00	662.82
2-W23-4	8/05/85	474.52	0.00	662.82
2-W23-4	8/06/85	474.61	0.00	662.82
2-W23-4	8/07/85	474.57	0.00	662.82
2-W23-4	8/08/85	474.44	0.00	662.82
2-W23-4	8/09/85	474.50	0.00	662.82
2-W23-4	8/10/85	474.46	0.00	662.82
2-W23-4	8/11/85	474.50	0.00	662.82
2-W23-4	8/12/85	474.55	0.00	662.82
2-W23-4	8/13/85	474.18	0.00	662.82
2-W23-4	8/14/85	474.35	0.00	662.82
2-W23-4	8/15/85	474.47	0.00	662.82
2-W23-4	8/16/85	474.26	0.00	662.82
2-W23-4	8/17/85	474.31	0.00	662.82
2-W23-4	8/18/85	474.28	0.00	662.82
2-W23-4	8/19/85	474.25	0.00	662.82
2-W23-4	8/20/85	474.17	0.00	662.82
2-W23-4	8/21/85	474.14	0.00	662.82
2-W23-4	8/22/85	474.11	0.00	662.82
2-W23-4	8/23/85	474.17	0.00	662.82
2-W23-4	8/24/85	474.27	0.00	662.82
2-W23-4	8/25/85	474.26	0.00	662.82
2-W23-4	8/26/85	474.18	0.00	662.82
2-W23-4	8/27/85	474.15	0.00	662.82
2-W23-4	8/28/85	474.11	0.00	662.82
2-W23-4	8/29/85	474.16	0.00	662.82
2-W23-4	8/30/85	474.05	0.00	662.82
2-W23-4	8/31/85	473.94	0.00	662.82
2-W23-4	9/01/85	474.14	0.00	662.82
2-W23-4	9/02/85	474.06	0.00	662.82
2-W23-4	9/03/85	474.17	0.00	662.82
2-W23-4	12/17/85	472.64	0.00	662.82
2-W23-4	12/08/86	470.13	0.00	662.82
2-W23-4	12/14/87	472.33	0.00	662.82
2-W23-4	1/06/88	472.33	0.00	662.82

Table C.5. Water Level Data for Well 299-W23-4 (Sheet 9 of 9).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
2-W23-4	2/12/88	472.09	0.00	662.82
2-W23-4	3/03/88	471.63	0.00	662.82
2-W23-4	3/09/88	471.60	0.00	662.82
2-W23-4	3/23/88	471.51	0.00	662.82
2-W23-4	12/30/88	469.96	0.00	662.82
2-W23-4	5/05/89	469.05	0.00	662.82

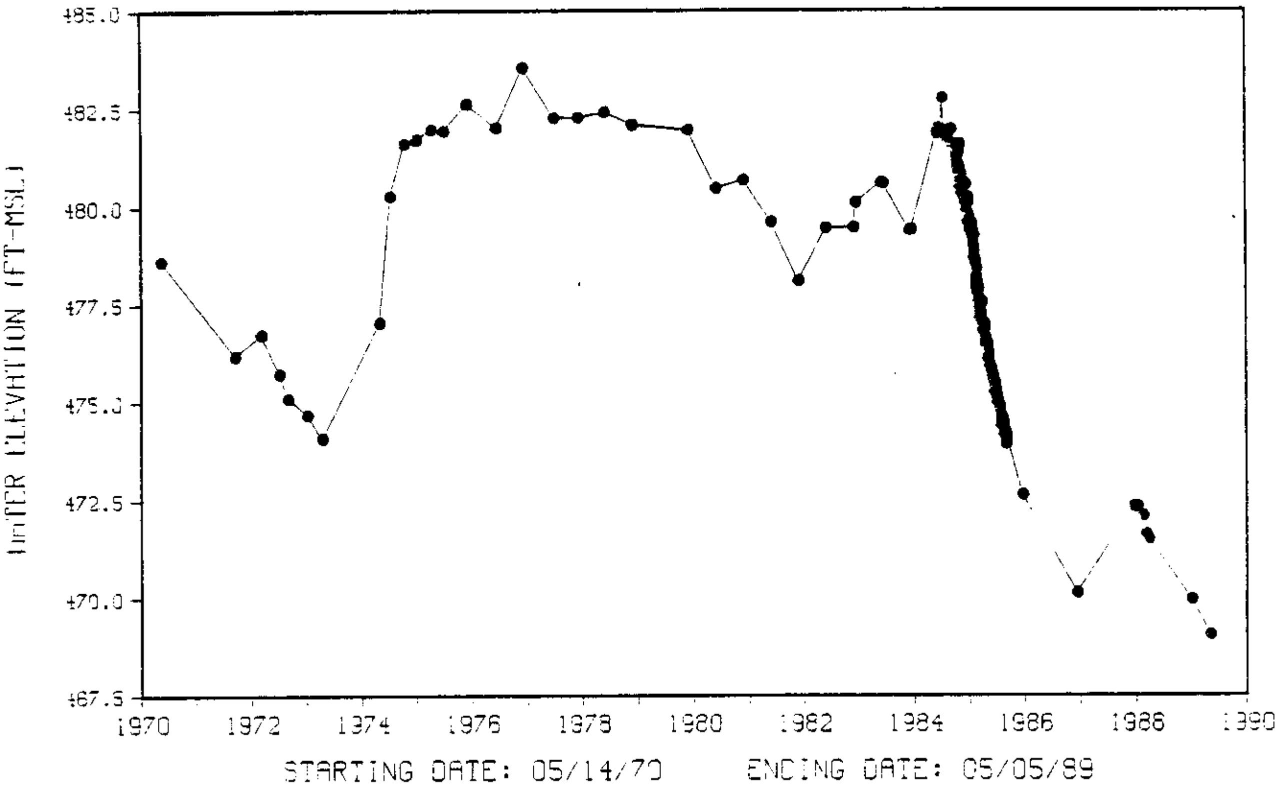

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Figure C.5. Data for Well 299-W23-4.

Table C.6. Water Level Data for Well 299-W26-3.

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
2-W26-3	3/20/68	0.00	476.29	650.83
2-W26-3	6/04/68	0.00	476.77	650.83
2-W26-3	4/13/73	0.00	470.22	650.83
2-W26-3	7/16/73	0.00	470.19	650.83
2-W26-3	8/14/73	0.00	469.64	650.83
2-W26-3	9/14/73	0.00	469.41	650.83
2-W26-3	10/04/73	0.00	469.72	650.83
2-W26-3	10/18/73	0.00	469.69	650.83
2-W26-3	5/02/74	0.00	471.49	650.83
2-W26-3	7/15/74	0.00	471.96	650.83
2-W26-3	1/08/75	0.00	472.63	650.83
2-W26-3	4/14/75	0.00	473.09	650.83
2-W26-3	3/03/89	464.68	0.00	650.83
2-W26-3	5/05/89	464.82	0.00	650.83

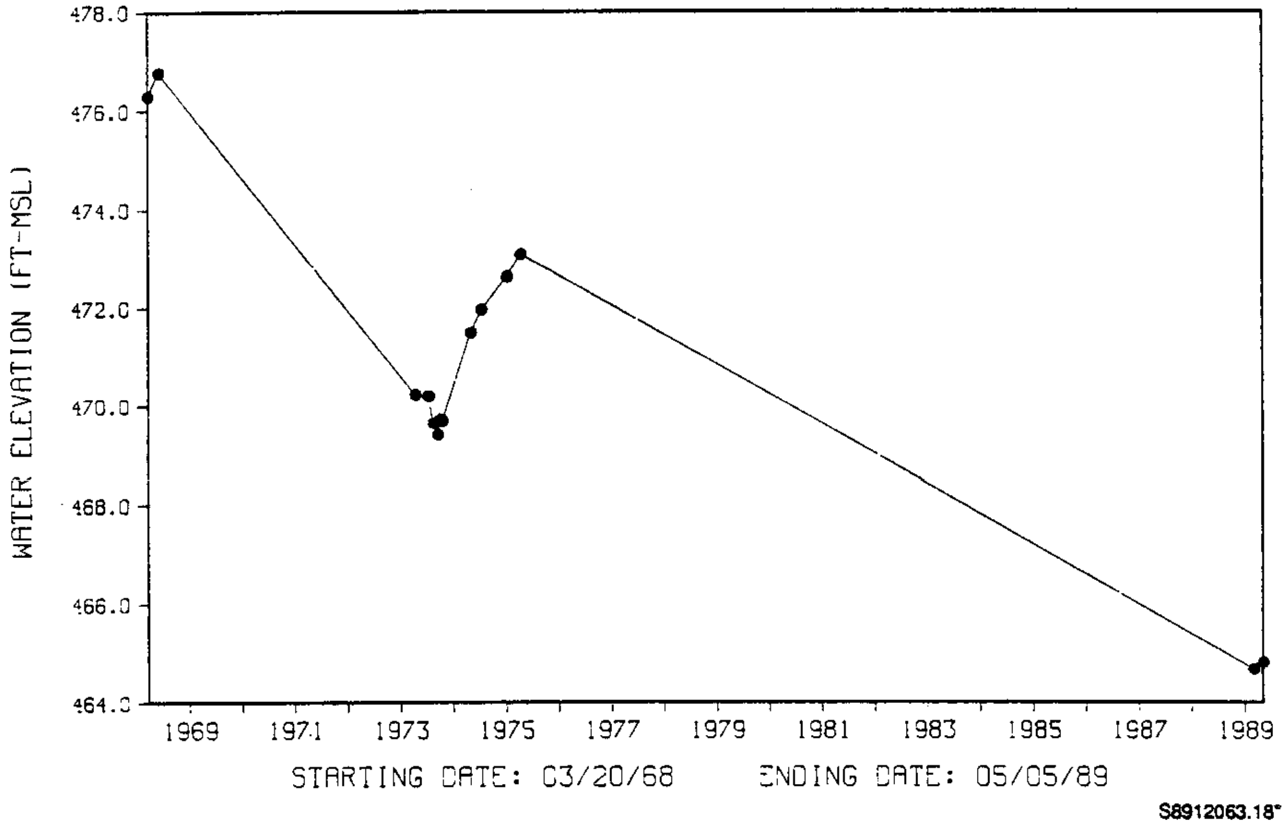

Figure C.6. Data for Well 299-W26-3.

Table C.7. Water Level Data for Well 699-29-78 (Sheet 1 of 2).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
6-29-78	12/31/62	0.00	470.38	647.05
6-29-78	7/29/63	0.00	471.80	647.05
6-29-78	12/20/63	0.00	472.86	647.05
6-29-78	1/18/65	0.00	475.52	647.05
6-29-78	8/19/65	0.00	477.39	647.05
6-29-78	9/23/65	0.00	477.21	647.05
6-29-78	10/18/65	0.00	477.67	647.05
6-29-78	12/30/65	0.00	478.20	647.05
6-29-78	3/02/66	0.00	478.66	647.05
6-29-78	4/12/66	0.00	478.81	647.05
6-29-78	5/18/66	0.00	479.09	647.05
6-29-78	7/21/66	0.00	479.13	647.05
6-29-78	10/28/66	0.00	479.55	647.05
6-29-78	1/03/67	0.00	479.85	647.05
6-29-78	3/28/67	0.00	480.61	647.05
6-29-78	10/12/67	0.00	478.83	647.05
6-29-78	3/20/68	0.00	478.54	647.05
6-29-78	4/23/69	0.00	479.01	647.05
6-29-78	5/13/70	0.00	474.87	647.05
6-29-78	9/14/71	0.00	474.63	647.05
6-29-78	3/09/72	0.00	473.35	647.05
6-29-78	7/07/72	0.00	472.17	647.05
6-29-78	10/03/72	0.00	471.51	647.05
6-29-78	1/09/73	0.00	471.26	647.05
6-29-78	4/13/73	0.00	470.72	647.05
6-29-78	7/18/73	0.00	470.47	647.05
6-29-78	8/15/73	0.00	470.74	647.05
6-29-78	8/28/73	0.00	470.62	647.05
6-29-78	9/14/73	0.00	470.57	647.05
6-29-78	10/04/73	0.00	470.95	647.05
6-29-78	10/18/73	0.00	470.97	647.05
6-29-78	4/15/74	0.00	472.33	647.05
6-29-78	7/09/74	0.00	472.45	647.05
6-29-78	10/18/74	0.00	472.26	647.05
6-29-78	1/08/75	0.00	471.66	647.05
6-29-78	4/14/75	0.00	471.54	647.05
6-29-78	7/07/75	0.00	471.31	647.05
6-29-78	12/03/75	0.00	471.36	647.05
6-29-78	6/15/76	0.00	470.85	647.05
6-29-78	12/08/76	0.00	471.24	647.05
6-29-78	7/01/77	0.00	471.55	647.05
6-29-78	12/07/77	0.00	471.17	647.05
6-29-78	6/01/78	0.00	471.47	647.05
6-29-78	12/01/78	0.00	471.68	647.05

Table C.7. Water Level Data for Well 699-29-78 (Sheet 2 of 2).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
6-29-78	12/01/79	0.00	470.77	647.05
6-29-78	6/01/80	0.00	470.26	647.05
6-29-78	12/01/80	0.00	471.01	647.05
6-29-78	6/01/81	0.00	470.14	647.05
6-29-78	12/01/81	0.00	469.80	647.05
6-29-78	6/01/82	0.00	469.57	647.05
6-29-78	12/01/82	0.00	469.55	647.05
6-29-78	6/01/83	0.00	469.32	647.05
6-29-78	12/01/83	0.00	469.59	647.05
6-29-78	6/01/84	0.00	469.98	647.05
6-29-78	12/01/84	0.00	470.04	647.05
6-29-78	7/12/85	469.25	0.00	647.05
6-29-78	12/30/85	468.50	0.00	647.05
6-29-78	12/09/86	466.65	0.00	647.05
6-29-78	12/11/87	465.04	0.00	647.05
6-29-78	12/14/87	465.98	0.00	647.05
6-29-78	12/21/87	465.68	0.00	647.05
6-29-78	4/28/88	465.55	0.00	647.05
6-29-78	8/25/88	0.00	0.00	647.05
6-29-78	12/09/88	465.14	0.00	647.05
6-29-78	3/03/89	464.57	0.00	647.05
6-29-78	5/05/89	464.75	0.00	647.05
6-29-78	6/09/89	464.70	0.00	647.05

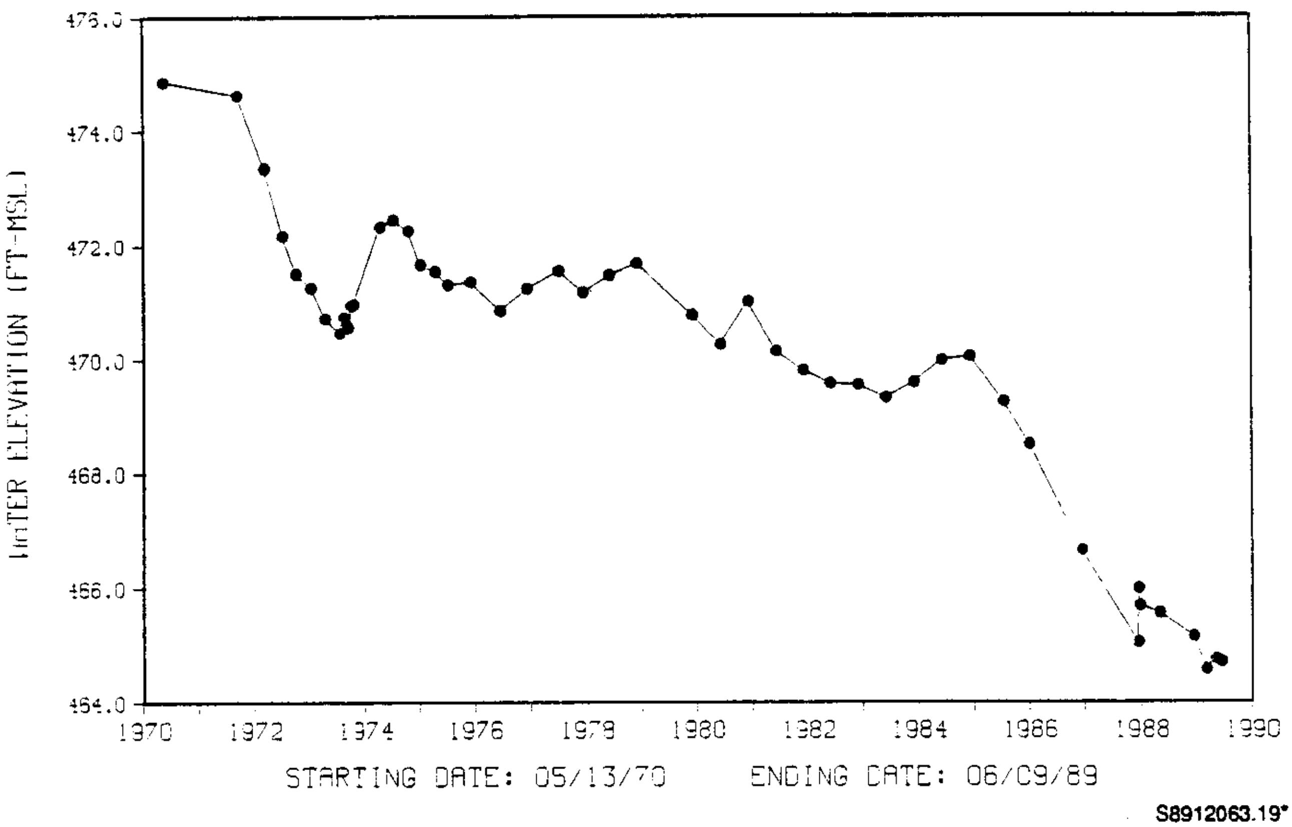

Figure C.7. Data for Well 699-29-78.

Table C.8. Water Level Data for Well 699-32-72 (Sheet 1 of 3).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
6-32-72	9/18/57	0.00	443.01	668.16
6-32-72	10/24/57	0.00	442.85	668.16
6-32-72	11/20/57	0.00	442.78	668.16
6-32-72	12/20/57	0.00	443.86	668.16
6-32-72	1/27/58	0.00	443.74	668.16
6-32-72	2/17/58	0.00	444.03	668.16
6-32-72	3/21/58	0.00	444.56	668.16
6-32-72	4/23/58	0.00	444.23	668.16
6-32-72	6/23/58	0.00	444.77	668.16
6-32-72	9/02/58	0.00	444.78	668.16
6-32-72	11/07/58	0.00	445.05	668.16
6-32-72	12/15/58	0.00	445.31	668.16
6-32-72	3/20/59	0.00	445.61	668.16
6-32-72	6/26/59	0.00	446.45	668.16
6-32-72	9/29/59	0.00	446.17	668.16
6-32-72	12/29/59	0.00	446.94	668.16
6-32-72	3/25/60	0.00	447.58	668.16
6-32-72	6/22/60	0.00	447.54	668.16
6-32-72	9/21/60	0.00	447.71	668.16
6-32-72	12/07/60	0.00	447.69	668.16
6-32-72	3/22/61	0.00	448.75	668.16
6-32-72	6/26/61	0.00	449.33	668.16
6-32-72	12/13/61	0.00	450.12	668.16
6-32-72	2/28/62	0.00	450.57	668.16
6-32-72	7/25/62	0.00	451.09	668.16
6-32-72	1/11/63	0.00	450.77	668.16
6-32-72	7/29/63	0.00	452.37	668.16
6-32-72	12/19/63	0.00	453.05	668.16
6-32-72	1/18/65	0.00	454.08	668.16
6-32-72	8/16/65	0.00	455.40	668.16
6-32-72	9/20/65	0.00	455.43	668.16
6-32-72	10/18/65	0.00	455.75	668.16
6-32-72	3/02/66	0.00	456.52	668.16
6-32-72	4/11/66	0.00	456.35	668.16
6-32-72	5/18/66	0.00	456.82	668.16
6-32-72	7/21/66	0.00	457.02	668.16
6-32-72	10/31/66	0.00	457.04	668.16
6-32-72	1/03/67	0.00	457.77	668.16
6-32-72	3/28/67	0.00	458.58	668.16
6-32-72	10/19/67	0.00	458.48	668.16
6-32-72	3/20/68	0.00	458.35	668.16
6-32-72	4/23/69	0.00	460.03	668.16
6-32-72	5/13/70	0.00	459.05	668.16
6-32-72	9/09/71	0.00	458.86	668.16

Table C.8. Water Level Data for Well 699-32-72 (Sheet 2 of 3).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
6-32-72	9/14/71	0.00	457.86	668.16
6-32-72	3/09/72	0.00	458.84	668.16
6-32-72	7/07/72	0.00	457.98	668.16
6-32-72	10/24/72	0.00	457.75	668.16
6-32-72	1/08/73	0.00	457.29	668.16
6-32-72	4/13/73	0.00	457.73	668.16
6-32-72	7/18/73	0.00	457.11	668.16
6-32-72	8/14/73	0.00	457.02	668.16
6-32-72	8/31/73	0.00	457.07	668.16
6-32-72	9/14/73	0.00	456.86	668.16
6-32-72	10/04/73	0.00	456.87	668.16
6-32-72	10/18/73	0.00	456.79	668.16
6-32-72	4/18/74	0.00	456.75	668.16
6-32-72	7/10/74	0.00	457.17	668.16
6-32-72	10/18/74	0.00	457.50	668.16
6-32-72	1/08/75	0.00	457.61	668.16
6-32-72	4/14/75	0.00	458.23	668.16
6-32-72	7/07/75	0.00	458.08	668.16
6-32-72	7/15/75	0.00	458.08	668.16
6-32-72	12/03/75	0.00	458.52	668.16
6-32-72	6/15/76	0.00	458.62	668.16
6-32-72	12/08/76	0.00	459.04	668.16
6-32-72	7/01/77	0.00	459.07	668.16
6-32-72	12/07/77	0.00	459.04	668.16
6-32-72	6/01/78	0.00	459.48	668.16
6-32-72	12/01/78	0.00	458.96	668.16
6-32-72	12/01/79	0.00	459.10	668.16
6-32-72	6/01/80	0.00	458.67	668.16
6-32-72	12/01/80	0.00	458.76	668.16
6-32-72	6/01/81	0.00	457.93	668.16
6-32-72	12/01/81	0.00	457.48	668.16
6-32-72	6/01/82	0.00	456.18	668.16
6-32-72	12/01/82	0.00	456.07	668.16
6-32-72	6/01/83	0.00	458.56	668.16
6-32-72	12/01/83	0.00	457.22	668.16
6-32-72	6/01/84	0.00	458.66	668.16
6-32-72	12/01/84	0.00	459.19	668.16
6-32-72	6/18/85	458.46	0.00	668.16
6-32-72	12/13/85	457.40	0.00	668.16
6-32-72	8/11/86	457.16	0.00	668.16
6-32-72	12/09/86	456.13	0.00	668.16
6-32-72	10/14/87	455.90	0.00	668.16
6-32-72	12/10/87	455.47	0.00	668.16
6-32-72	12/14/87	455.66	0.00	668.16

Table C.8. Water Level Data for Well 699-32-72 (Sheet 3 of 3).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
6-32-72	5/11/88	455.13	0.00	668.16
6-32-72	8/24/88	455.32	0.00	668.16
6-32-72	12/09/88	455.08	0.00	668.16
6-32-72	3/03/89	454.94	0.00	668.16
6-32-72	5/05/89	454.88	0.00	668.16
6-32-72	6/09/89	455.01	0.00	668.16

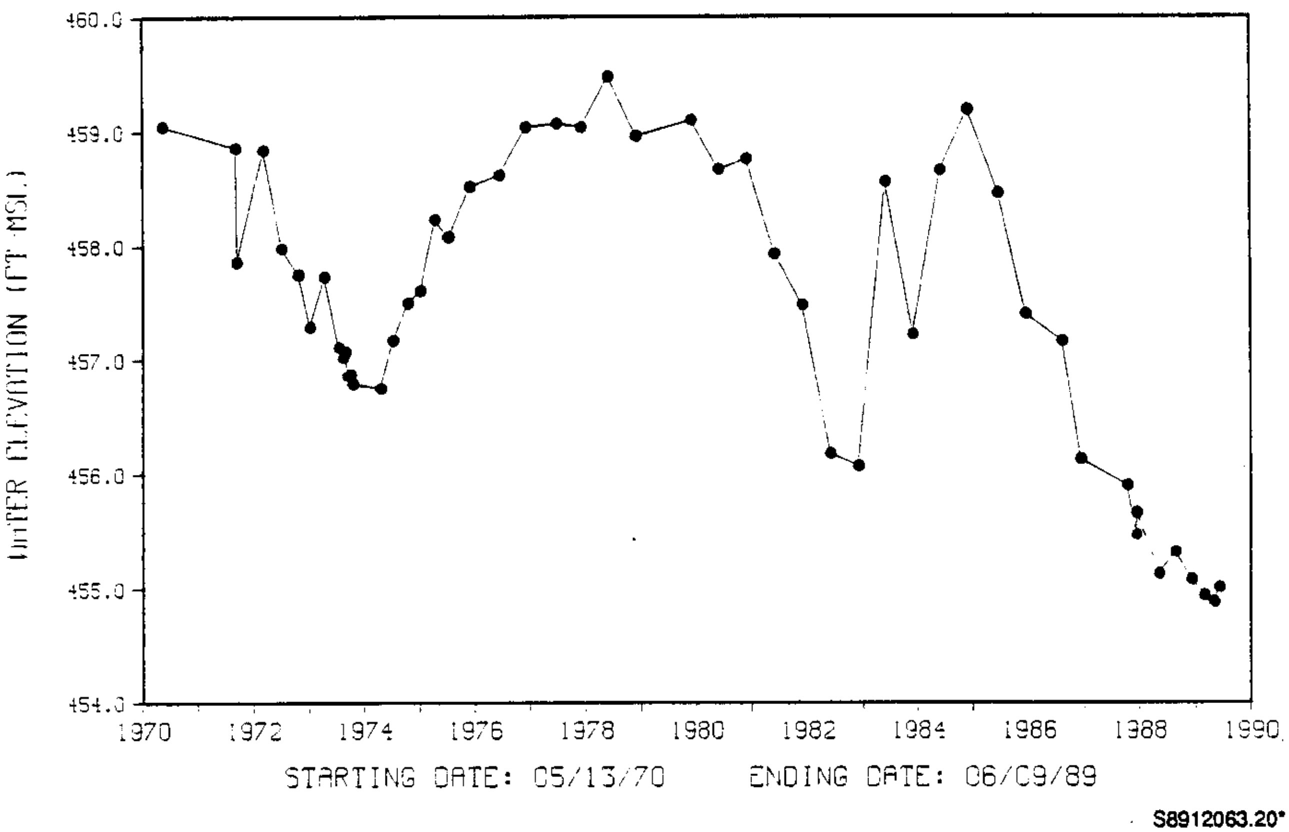

Figure C.8. Data for Well 699-32-72.

Table C.9. Water Level Data for Well 699-32-77 (Sheet 1 of 6).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
6-32-77	8/28/51	0.00	415.44	653.74
6-32-77	9/25/51	0.00	415.66	653.74
6-32-77	10/30/51	0.00	415.45	653.74
6-32-77	11/27/51	0.00	416.18	653.74
6-32-77	12/26/51	0.00	416.00	653.74
6-32-77	1/29/52	0.00	416.74	653.74
6-32-77	2/26/52	0.00	417.60	653.74
6-32-77	3/26/52	0.00	418.49	653.74
6-32-77	4/29/52	0.00	420.41	653.74
6-32-77	5/27/52	0.00	421.78	653.74
6-32-77	6/24/52	0.00	422.53	653.74
6-32-77	7/29/52	0.00	425.99	653.74
6-32-77	8/26/52	0.00	428.14	653.74
6-32-77	9/30/52	0.00	431.69	653.74
6-32-77	10/28/52	0.00	435.60	653.74
6-32-77	11/25/52	0.00	441.19	653.74
6-32-77	12/30/52	0.00	446.17	653.74
6-32-77	1/27/53	0.00	445.94	653.74
6-32-77	2/24/53	0.00	450.48	653.74
6-32-77	3/31/53	0.00	452.19	653.74
6-32-77	4/28/53	0.00	454.29	653.74
6-32-77	5/26/53	0.00	455.24	653.74
6-32-77	6/30/53	0.00	457.00	653.74
6-32-77	7/28/53	0.00	457.97	653.74
6-32-77	8/25/53	0.00	458.66	653.74
6-32-77	9/29/53	0.00	458.74	653.74
6-32-77	10/27/53	0.00	459.32	653.74
6-32-77	11/24/53	0.00	459.54	653.74
6-32-77	12/29/53	0.00	461.24	653.74
6-32-77	1/26/54	0.00	461.04	653.74
6-32-77	2/23/54	0.00	460.26	653.74
6-32-77	3/23/54	0.00	461.09	653.74
6-32-77	4/27/54	0.00	459.90	653.74
6-32-77	5/25/54	0.00	457.74	653.74
6-32-77	6/29/54	0.00	456.47	653.74
6-32-77	7/27/54	0.00	455.65	653.74
6-32-77	8/31/54	0.00	454.84	653.74
6-32-77	9/28/54	0.00	454.69	653.74
6-32-77	10/26/54	0.00	454.10	653.74
6-32-77	11/30/54	0.00	454.19	653.74
6-32-77	12/28/54	0.00	454.56	653.74
6-32-77	1/25/55	0.00	454.82	653.74
6-32-77	2/23/55	0.00	455.14	653.74
6-32-77	3/29/55	0.00	456.00	653.74

Table C.9. Water Level Data for Well 699-32-77 (Sheet 2 of 6).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
6-32-77	4/26/55	0.00	455.90	653.74
6-32-77	5/24/55	0.00	456.10	653.74
6-32-77	6/28/55	0.00	456.99	653.74
6-32-77	7/26/55	0.00	457.14	653.74
6-32-77	8/30/55	0.00	459.20	653.74
6-32-77	9/27/55	0.00	459.14	653.74
6-32-77	10/25/55	0.00	460.37	653.74
6-32-77	11/29/55	0.00	460.74	653.74
6-32-77	12/27/55	0.00	461.26	653.74
6-32-77	1/31/56	0.00	460.80	653.74
6-32-77	2/10/56	0.00	461.64	653.74
6-32-77	2/18/56	0.00	461.64	653.74
6-32-77	2/26/56	0.00	461.69	653.74
6-32-77	3/01/56	0.00	461.64	653.74
6-32-77	3/10/56	0.00	461.44	653.74
6-32-77	3/18/56	0.00	461.79	653.74
6-32-77	3/30/56	0.00	461.84	653.74
6-32-77	4/06/56	0.00	461.84	653.74
6-32-77	4/13/56	0.00	461.89	653.74
6-32-77	4/20/56	0.00	461.74	653.74
6-32-77	4/28/56	0.00	461.94	653.74
6-32-77	5/05/56	0.00	461.89	653.74
6-32-77	5/11/56	0.00	461.64	653.74
6-32-77	5/22/56	0.00	461.79	653.74
6-32-77	6/08/56	0.00	462.09	653.74
6-32-77	6/16/56	0.00	462.34	653.74
6-32-77	6/23/56	0.00	462.34	653.74
6-32-77	7/03/56	0.00	462.47	653.74
6-32-77	7/10/56	0.00	462.63	653.74
6-32-77	7/17/56	0.00	462.74	653.74
6-32-77	7/24/56	0.00	462.72	653.74
6-32-77	7/31/56	0.00	462.83	653.74
6-32-77	8/09/56	0.00	462.65	653.74
6-32-77	8/14/56	0.00	462.92	653.74
6-32-77	8/21/56	0.00	463.12	653.74
6-32-77	8/28/56	0.00	463.12	653.74
6-32-77	9/07/56	0.00	463.67	653.74
6-32-77	9/11/56	0.00	463.71	653.74
6-32-77	9/18/56	0.00	463.74	653.74
6-32-77	9/25/56	0.00	464.39	653.74
6-32-77	10/01/56	0.00	464.38	653.74
6-32-77	10/09/56	0.00	465.00	653.74
6-32-77	10/16/56	0.00	466.07	653.74
6-32-77	10/30/56	0.00	466.46	653.74

Table C.9. Water Level Data for Well 699-32-77 (Sheet 3 of 6).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
6-32-77	11/06/56	0.00	466.26	653.74
6-32-77	11/20/56	0.00	466.95	653.74
6-32-77	11/27/56	0.00	467.57	653.74
6-32-77	12/11/56	0.00	468.79	653.74
6-32-77	12/18/56	0.00	468.29	653.74
6-32-77	1/09/57	0.00	468.70	653.74
6-32-77	2/14/57	0.00	467.61	653.74
6-32-77	3/28/57	0.00	467.49	653.74
6-32-77	4/26/57	0.00	464.51	653.74
6-32-77	5/17/57	0.00	464.25	653.74
6-32-77	6/13/57	0.00	463.24	653.74
6-32-77	8/26/57	0.00	462.91	653.74
6-32-77	9/18/57	0.00	461.23	653.74
6-32-77	10/22/57	0.00	461.80	653.74
6-32-77	11/20/57	0.00	461.43	653.74
6-32-77	12/20/57	0.00	462.15	653.74
6-32-77	1/27/58	0.00	462.03	653.74
6-32-77	2/17/58	0.00	462.30	653.74
6-32-77	3/21/58	0.00	463.09	653.74
6-32-77	4/23/58	0.00	462.46	653.74
6-32-77	6/23/58	0.00	462.69	653.74
6-32-77	9/02/58	0.00	461.83	653.74
6-32-77	11/07/58	0.00	463.21	653.74
6-32-77	12/15/58	0.00	463.37	653.74
6-32-77	3/20/59	0.00	463.46	653.74
6-32-77	6/26/59	0.00	463.67	653.74
6-32-77	9/29/59	0.00	463.57	653.74
6-32-77	12/22/59	0.00	464.30	653.74
6-32-77	4/04/60	0.00	464.94	653.74
6-32-77	6/22/60	0.00	465.20	653.74
6-32-77	9/21/60	0.00	465.38	653.74
6-32-77	12/07/60	0.00	465.66	653.74
6-32-77	3/22/61	0.00	466.93	653.74
6-32-77	6/26/61	0.00	467.24	653.74
6-32-77	12/13/61	0.00	468.41	653.74
6-32-77	2/28/62	0.00	468.27	653.74
6-32-77	7/25/62	0.00	468.07	653.74
6-32-77	1/11/63	0.00	468.03	653.74
6-32-77	7/29/63	0.00	469.55	653.74
6-32-77	12/19/63	0.00	470.65	653.74
6-32-77	1/18/65	0.00	473.07	653.74
6-32-77	8/16/65	0.00	474.78	653.74
6-32-77	9/20/65	0.00	474.58	653.74
6-32-77	10/18/65	0.00	474.88	653.74

Table C.9. Water Level Data for Well 699-32-77 (Sheet 4 of 6).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
6-32-77	12/30/65	0.00	475.55	653.74
6-32-77	3/02/66	0.00	475.73	653.74
6-32-77	4/11/66	0.00	475.96	653.74
6-32-77	5/18/66	0.00	476.06	653.74
6-32-77	7/21/66	0.00	476.40	653.74
6-32-77	10/31/66	0.00	476.46	653.74
6-32-77	1/03/67	0.00	477.34	653.74
6-32-77	3/28/67	0.00	477.87	653.74
6-32-77	10/19/67	0.00	475.56	653.74
6-32-77	3/20/68	0.00	475.12	653.74
6-32-77	4/23/69	0.00	475.76	653.74
6-32-77	5/12/70	0.00	472.88	653.74
6-32-77	9/14/71	0.00	471.02	653.74
6-32-77	3/10/72	0.00	471.67	653.74
6-32-77	7/06/72	0.00	470.61	653.74
6-32-77	10/24/72	0.00	469.29	653.74
6-32-77	1/08/73	0.00	469.08	653.74
6-32-77	4/10/73	0.00	468.85	653.74
6-32-77	7/17/73	0.00	468.42	653.74
6-32-77	8/14/73	0.00	468.23	653.74
6-32-77	8/31/73	0.00	468.24	653.74
6-32-77	9/14/73	0.00	468.03	653.74
6-32-77	10/04/73	0.00	468.26	653.74
6-32-77	10/18/73	0.00	468.21	653.74
6-32-77	4/18/74	0.00	469.38	653.74
6-32-77	7/10/74	0.00	469.91	653.74
6-32-77	10/18/74	0.00	470.25	653.74
6-32-77	1/08/75	0.00	470.46	653.74
6-32-77	4/14/75	0.00	470.79	653.74
6-32-77	7/07/75	0.00	470.41	653.74
6-32-77	12/03/75	0.00	470.01	653.74
6-32-77	6/15/76	0.00	470.66	653.74
6-32-77	12/08/76	0.00	471.24	653.74
6-32-77	7/01/77	0.00	471.45	653.74
6-32-77	12/07/77	0.00	471.22	653.74
6-32-77	6/01/78	0.00	471.56	653.74
6-32-77	12/01/78	0.00	470.85	653.74
6-32-77	12/01/79	0.00	470.44	653.74
6-32-77	6/01/80	0.00	469.70	653.74
6-32-77	12/01/80	0.00	470.43	653.74
6-32-77	6/01/81	0.00	469.46	653.74
6-32-77	12/01/81	0.00	469.56	653.74
6-32-77	6/01/82	0.00	469.03	653.74
6-32-77	12/01/82	0.00	469.00	653.74

Table C.9. Water Level Data for Well 699-32-77 (Sheet 5 of 6).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
6-32-77	12/15/82	468.99	0.00	653.74
6-32-77	6/01/83	0.00	469.45	653.74
6-32-77	6/15/83	469.45	0.00	653.74
6-32-77	12/01/83	0.00	469.22	653.74
6-32-77	12/15/83	469.22	0.00	653.74
6-32-77	5/29/84	0.00	470.28	653.74
6-32-77	5/29/84	470.28	0.00	653.74
6-32-77	6/01/84	0.00	470.04	653.74
6-32-77	6/11/84	0.00	470.13	653.74
6-32-77	6/11/84	470.13	0.00	653.74
6-32-77	6/15/84	470.04	0.00	653.74
6-32-77	6/18/84	0.00	470.06	653.74
6-32-77	6/18/84	470.06	0.00	653.74
6-32-77	6/25/84	0.00	470.09	653.74
6-32-77	6/25/84	470.09	0.00	653.74
6-32-77	7/10/84	0.00	469.97	653.74
6-32-77	7/10/84	469.97	0.00	653.74
6-32-77	7/22/84	0.00	470.06	653.74
6-32-77	7/23/84	470.06	0.00	653.74
6-32-77	8/06/84	469.93	0.00	653.74
6-32-77	8/19/84	0.00	470.07	653.74
6-32-77	8/20/84	470.07	0.00	653.74
6-32-77	9/04/84	0.00	470.40	653.74
6-32-77	9/05/84	470.40	0.00	653.74
6-32-77	12/01/84	0.00	470.42	653.74
6-32-77	5/02/85	469.25	0.00	653.74
6-32-77	5/13/85	468.64	0.00	653.74
6-32-77	5/27/85	468.84	0.00	653.74
6-32-77	6/12/85	468.67	0.00	653.74
6-32-77	6/12/85	468.67	0.00	653.74
6-32-77	6/26/85	468.55	0.00	653.74
6-32-77	7/09/85	468.32	0.00	653.74
6-32-77	8/05/85	468.03	0.00	653.74
6-32-77	12/27/85	467.37	0.00	653.74
6-32-77	12/09/86	465.01	0.00	653.74
6-32-77	12/11/87	463.58	0.00	653.74
6-32-77	12/15/87	464.47	0.00	653.74
6-32-77	12/21/87	464.30	0.00	653.74
6-32-77	5/11/88	463.97	0.00	653.74
6-32-77	8/24/88	463.97	0.00	653.74
6-32-77	12/09/88	463.77	0.00	653.74

Table C.9. Water Level Data for Well 699-32-77 (Sheet 6 of 6).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
6-32-77	3/03/89	463.27	0.00	653.74
6-32-77	5/05/89	463.40	0.00	653.74
6-32-77	6/09/89	463.39	0.00	653.74

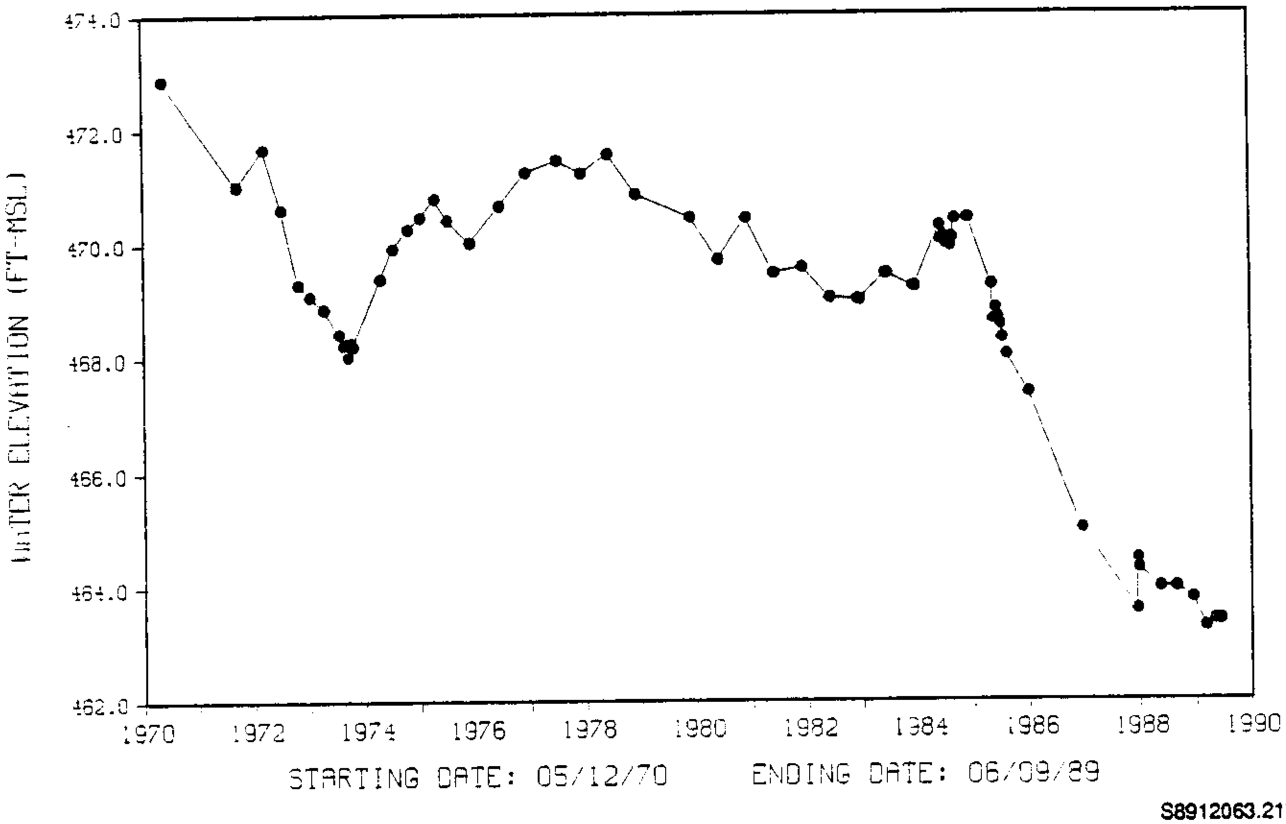

Figure C.9. Data for Well 699-32-77.

Table C.10. Water Level Data for Well 699-35-78A (Sheet 1 of 6).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
6-35-78A	1/15/51	0.00	422.57	660.65
6-35-78A	2/26/51	0.00	422.23	660.65
6-35-78A	3/22/51	0.00	422.48	660.65
6-35-78A	4/18/51	0.00	423.02	660.65
6-35-78A	5/16/51	0.00	423.17	660.65
6-35-78A	6/15/51	0.00	423.52	660.65
6-35-78A	7/17/51	0.00	423.87	660.65
6-35-78A	8/17/51	0.00	424.24	660.65
6-35-78A	9/14/51	0.00	424.55	660.65
6-35-78A	10/19/51	0.00	425.42	660.65
6-35-78A	11/15/51	0.00	424.85	660.65
6-35-78A	1/21/52	0.00	426.64	660.65
6-35-78A	3/18/52	0.00	427.96	660.65
6-35-78A	4/15/52	0.00	428.26	660.65
6-35-78A	5/15/52	0.00	429.26	660.65
6-35-78A	6/18/52	0.00	430.65	660.65
6-35-78A	7/18/52	0.00	431.69	660.65
6-35-78A	8/20/52	0.00	432.78	660.65
6-35-78A	9/30/52	0.00	435.45	660.65
6-35-78A	10/28/52	0.00	437.24	660.65
6-35-78A	11/25/52	0.00	439.25	660.65
6-35-78A	12/30/52	0.00	442.38	660.65
6-35-78A	1/27/53	0.00	443.79	660.65
6-35-78A	2/24/53	0.00	445.94	660.65
6-35-78A	3/31/53	0.00	447.55	660.65
6-35-78A	4/28/53	0.00	449.44	660.65
6-35-78A	5/26/53	0.00	450.42	660.65
6-35-78A	6/30/53	0.00	451.89	660.65
6-35-78A	7/28/53	0.00	452.87	660.65
6-35-78A	8/25/53	0.00	454.08	660.65
6-35-78A	9/29/53	0.00	455.27	660.65
6-35-78A	10/27/53	0.00	456.60	660.65
6-35-78A	11/24/53	0.00	457.55	660.65
6-35-78A	12/29/53	0.00	459.45	660.65
6-35-78A	1/26/54	0.00	459.60	660.65
6-35-78A	2/23/54	0.00	461.31	660.65
6-35-78A	3/30/54	0.00	462.63	660.65
6-35-78A	4/27/54	0.00	463.58	660.65
6-35-78A	5/25/54	0.00	464.52	660.65
6-35-78A	6/29/54	0.00	464.98	660.65
6-35-78A	7/27/54	0.00	465.38	660.65
6-35-78A	8/31/54	0.00	466.04	660.65
6-35-78A	9/28/54	0.00	466.88	660.65
6-35-78A	10/26/54	0.00	467.23	660.65

Table C.10. Water Level Data for Well 699-35-78A (Sheet 2 of 6).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
6-35-78A	11/30/54	0.00	468.25	660.65
6-35-78A	12/28/54	0.00	468.38	660.65
6-35-78A	1/25/55	0.00	468.57	660.65
6-35-78A	2/23/55	0.00	469.31	660.65
6-35-78A	3/29/55	0.00	470.21	660.65
6-35-78A	4/26/55	0.00	470.37	660.65
6-35-78A	5/24/55	0.00	470.52	660.65
6-35-78A	6/28/55	0.00	471.39	660.65
6-35-78A	7/26/55	0.00	471.45	660.65
6-35-78A	8/16/55	0.00	471.62	660.65
6-35-78A	10/19/55	0.00	472.05	660.65
6-35-78A	11/29/55	0.00	472.63	660.65
6-35-78A	12/29/55	0.00	472.55	660.65
6-35-78A	1/25/56	0.00	472.65	660.65
6-35-78A	2/24/56	0.00	473.40	660.65
6-35-78A	3/20/56	0.00	474.00	660.65
6-35-78A	4/15/56	0.00	474.20	660.65
6-35-78A	5/29/56	0.00	475.79	660.65
6-35-78A	8/09/56	0.00	475.63	660.65
6-35-78A	9/14/56	0.00	476.05	660.65
6-35-78A	10/09/56	0.00	476.27	660.65
6-35-78A	11/26/56	0.00	477.00	660.65
6-35-78A	12/18/56	0.00	477.30	660.65
6-35-78A	1/09/57	0.00	477.30	660.65
6-35-78A	1/15/57	0.00	477.00	660.65
6-35-78A	2/05/57	0.00	477.60	660.65
6-35-78A	2/12/57	0.00	477.22	660.65
6-35-78A	2/26/57	0.00	477.32	660.65
6-35-78A	3/26/57	0.00	477.00	660.65
6-35-78A	4/02/57	0.00	476.84	660.65
6-35-78A	4/10/57	0.00	477.00	660.65
6-35-78A	4/17/57	0.00	476.88	660.65
6-35-78A	4/25/57	0.00	476.55	660.65
6-35-78A	5/03/57	0.00	476.20	660.65
6-35-78A	5/17/57	0.00	476.75	660.65
6-35-78A	6/14/57	0.00	475.95	660.65
6-35-78A	6/24/57	0.00	475.60	660.65
6-35-78A	7/05/57	0.00	475.75	660.65
6-35-78A	8/23/57	0.00	475.92	660.65
6-35-78A	9/20/57	0.00	474.89	660.65
6-35-78A	10/22/57	0.00	474.96	660.65
6-35-78A	11/20/57	0.00	474.25	660.65
6-35-78A	12/20/57	0.00	474.48	660.65
6-35-78A	1/27/58	0.00	474.09	660.65

Table C.10. Water Level Data for Well 699-35-78A (Sheet 3 of 6).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
6-35-78A	2/17/58	0.00	474.31	660.65
6-35-78A	3/21/58	0.00	474.47	660.65
6-35-78A	4/23/58	0.00	473.78	660.65
6-35-78A	6/23/58	0.00	473.57	660.65
6-35-78A	9/02/58	0.00	472.89	660.65
6-35-78A	11/07/58	0.00	472.75	660.65
6-35-78A	12/15/58	0.00	472.87	660.65
6-35-78A	3/20/59	0.00	472.57	660.65
6-35-78A	6/26/59	0.00	472.31	660.65
6-35-78A	9/29/59	0.00	471.50	660.65
6-35-78A	12/22/59	0.00	471.75	660.65
6-35-78A	4/04/60	0.00	472.02	660.65
6-35-78A	6/22/60	0.00	471.90	660.65
6-35-78A	9/21/60	0.00	471.79	660.65
6-35-78A	12/07/60	0.00	472.35	660.65
6-35-78A	3/22/61	0.00	473.43	660.65
6-35-78A	6/26/61	0.00	473.56	660.65
6-35-78A	12/13/61	0.00	474.30	660.65
6-35-78A	2/28/62	0.00	474.86	660.65
6-35-78A	7/25/62	0.00	474.34	660.65
6-35-78A	1/11/63	0.00	474.04	660.65
6-35-78A	7/31/63	0.00	475.40	660.65
6-35-78A	12/19/63	0.00	476.25	660.65
6-35-78A	1/18/65	0.00	478.66	660.65
6-35-78A	8/16/65	0.00	479.49	660.65
6-35-78A	9/20/65	0.00	479.49	660.65
6-35-78A	10/18/65	0.00	479.86	660.65
6-35-78A	12/30/65	0.00	480.13	660.65
6-35-78A	3/02/66	0.00	480.44	660.65
6-35-78A	4/12/66	0.00	480.48	660.65
6-35-78A	5/18/66	0.00	480.60	660.65
6-35-78A	7/21/66	0.00	480.71	660.65
6-35-78A	10/31/66	0.00	480.83	660.65
6-35-78A	1/03/67	0.00	481.70	660.65
6-35-78A	3/28/67	0.00	482.03	660.65
6-35-78A	10/19/67	0.00	480.36	660.65
6-35-78A	3/20/68	0.00	480.04	660.65
6-35-78A	4/23/69	0.00	480.72	660.65
6-35-78A	5/12/70	0.00	478.32	660.65
6-35-78A	9/14/71	0.00	476.21	660.65
6-35-78A	3/10/72	0.00	476.30	660.65
6-35-78A	7/06/72	0.00	476.00	660.65
6-35-78A	10/24/72	0.00	475.15	660.65
6-35-78A	1/08/73	0.00	474.57	660.65

Table C.10. Water Level Data for Well 699-35-78A (Sheet 4 of 6).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
6-35-78A	4/10/73	0.00	474.18	660.65
6-35-78A	7/18/73	0.00	473.50	660.65
6-35-78A	8/15/73	0.00	473.57	660.65
6-35-78A	8/28/73	0.00	473.29	660.65
6-35-78A	9/14/73	0.00	473.19	660.65
6-35-78A	10/04/73	0.00	473.43	660.65
6-35-78A	10/18/73	0.00	473.47	660.65
6-35-78A	4/18/74	0.00	476.55	660.65
6-35-78A	7/10/74	0.00	477.51	660.65
6-35-78A	10/18/74	0.00	478.22	660.65
6-35-78A	1/08/75	0.00	478.40	660.65
6-35-78A	4/14/75	0.00	478.62	660.65
6-35-78A	7/07/75	0.00	478.45	660.65
6-35-78A	12/03/75	0.00	478.30	660.65
6-35-78A	6/15/76	0.00	478.96	660.65
6-35-78A	12/08/76	0.00	478.09	660.65
6-35-78A	7/01/77	0.00	480.39	660.65
6-35-78A	7/15/77	0.00	479.39	660.65
6-35-78A	12/07/77	0.00	479.16	660.65
6-35-78A	6/01/78	0.00	479.30	660.65
6-35-78A	12/01/78	0.00	478.36	660.65
6-35-78A	12/01/79	0.00	478.10	660.65
6-35-78A	6/01/80	0.00	476.90	660.65
6-35-78A	12/01/80	0.00	477.79	660.65
6-35-78A	6/01/81	0.00	476.47	660.65
6-35-78A	12/01/81	0.00	475.81	660.65
6-35-78A	6/01/82	0.00	475.22	660.65
6-35-78A	12/01/82	0.00	476.41	660.65
6-35-78A	12/15/82	476.39	0.00	660.65
6-35-78A	6/01/83	0.00	476.80	660.65
6-35-78A	6/15/83	476.78	0.00	660.65
6-35-78A	12/01/83	0.00	477.26	660.65
6-35-78A	12/15/83	477.24	0.00	660.65
6-35-78A	5/29/84	0.00	478.22	660.65
6-35-78A	5/29/84	478.22	0.00	660.65
6-35-78A	6/01/84	0.00	478.05	660.65
6-35-78A	6/11/84	0.00	478.13	660.65
6-35-78A	6/11/84	478.13	0.00	660.65
6-35-78A	6/15/84	478.06	0.00	660.65
6-35-78A	6/18/84	0.00	478.06	660.65
6-35-78A	6/18/84	478.06	0.00	660.65
6-35-78A	6/25/84	0.00	478.07	660.65
6-35-78A	6/25/84	478.07	0.00	660.65
6-35-78A	7/10/84	0.00	477.97	660.65

Table C.10. Water Level Data for Well 699-35-78A (Sheet 5 of 6).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
6-35-78A	7/10/84	477.97	0.00	660.65
6-35-78A	7/22/84	0.00	478.02	660.65
6-35-78A	7/23/84	478.02	0.00	660.65
6-35-78A	8/06/84	477.87	0.00	660.65
6-35-78A	8/19/84	0.00	477.96	660.65
6-35-78A	8/20/84	477.96	0.00	660.65
6-35-78A	9/04/84	0.00	478.13	660.65
6-35-78A	9/05/84	478.13	0.00	660.65
6-35-78A	9/16/84	0.00	477.77	660.65
6-35-78A	9/17/84	477.77	0.00	660.65
6-35-78A	10/01/84	477.63	0.00	660.65
6-35-78A	10/17/84	477.69	0.00	660.65
6-35-78A	10/29/84	477.08	0.00	660.65
6-35-78A	11/19/84	476.96	0.00	660.65
6-35-78A	12/01/84	0.00	477.10	660.65
6-35-78A	12/10/84	477.15	0.00	660.65
6-35-78A	12/27/84	477.10	0.00	660.65
6-35-78A	1/08/85	476.63	0.00	660.65
6-35-78A	1/23/85	476.17	0.00	660.65
6-35-78A	2/04/85	475.83	0.00	660.65
6-35-78A	2/19/85	476.23	0.00	660.65
6-35-78A	3/05/85	475.78	0.00	660.65
6-35-78A	3/22/85	475.47	0.00	660.65
6-35-78A	4/02/85	474.97	0.00	660.65
6-35-78A	4/16/85	475.20	0.00	660.65
6-35-78A	5/02/85	475.13	0.00	660.65
6-35-78A	5/13/85	474.61	0.00	660.65
6-35-78A	5/27/85	474.58	0.00	660.65
6-35-78A	6/12/85	474.39	0.00	660.65
6-35-78A	6/12/85	474.39	0.00	660.65
6-35-78A	6/26/85	474.16	0.00	660.65
6-35-78A	7/09/85	473.85	0.00	660.65
6-35-78A	8/05/85	473.39	0.00	660.65
6-35-78A	12/27/85	472.20	0.00	660.65
6-35-78A	12/09/86	469.68	0.00	660.65
6-35-78A	8/28/87	469.12	0.00	660.65
6-35-78A	12/11/87	468.36	0.00	660.65
6-35-78A	12/15/87	469.16	0.00	660.65
6-35-78A	12/21/87	469.02	0.00	660.65
6-35-78A	8/25/88	467.83	0.00	660.65
6-35-78A	12/09/88	468.36	0.00	660.65

Table C.10. Water Level Data for Well 699-35-78A (Sheet 6 of 6).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
6-35-78A	1/12/89	468.07	0.00	660.65
6-35-78A	3/03/89	467.76	0.00	660.65
6-35-78A	5/05/89	467.91	0.00	660.65
6-35-78A	6/09/89	467.86	0.00	660.65

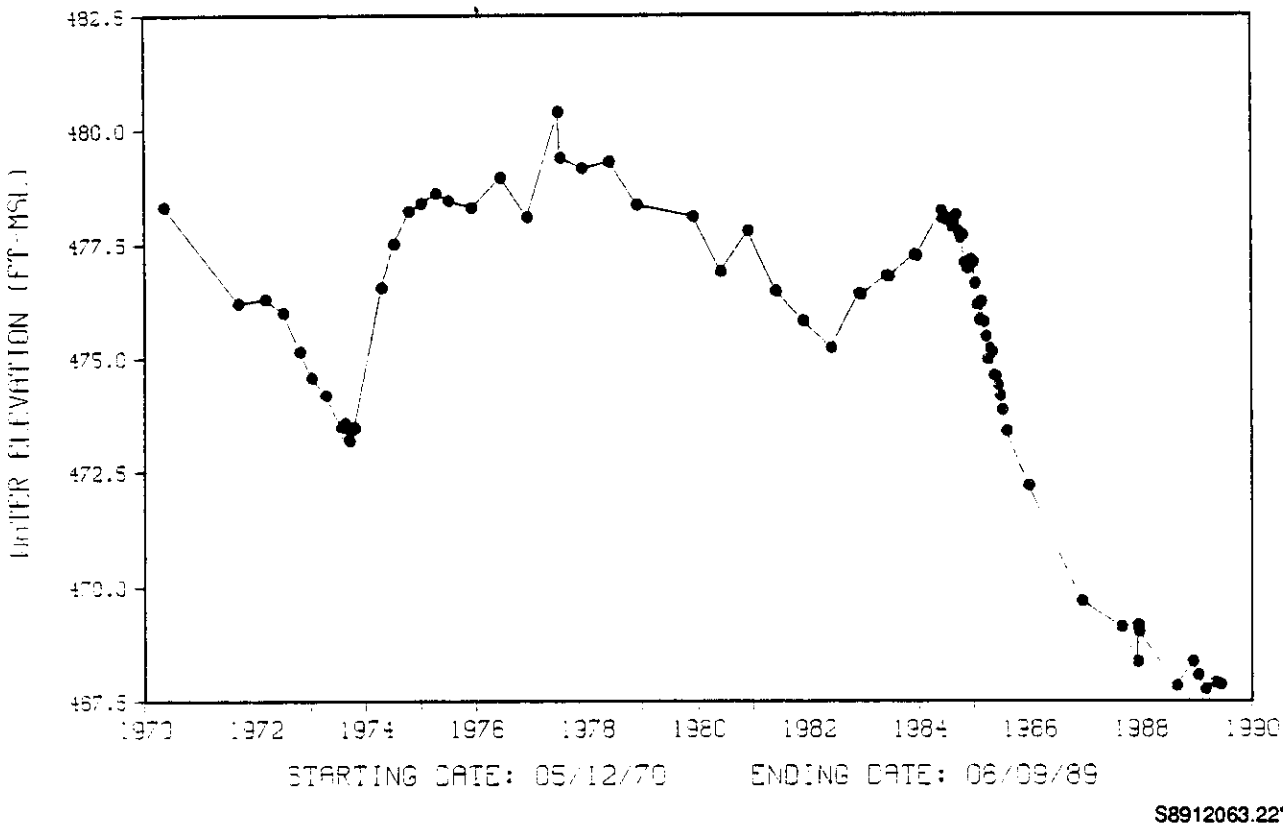

Figure C.10. Data for Well 699-35-78A.

Table C.11. Water Level Data for Well 699-37-82A (Sheet 1 of 3).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
6-37-82A	12/14/60	0.00	466.44	636.75
6-37-82A	3/21/61	0.00	467.06	636.75
6-37-82A	6/26/61	0.00	467.86	636.75
6-37-82A	12/13/61	0.00	468.65	636.75
6-37-82A	2/26/62	0.00	469.33	636.75
6-37-82A	7/05/62	0.00	469.55	636.75
6-37-82A	1/11/63	0.00	469.14	636.75
6-37-82A	7/31/63	0.00	470.89	636.75
6-37-82A	12/19/63	0.00	471.70	636.75
6-37-82A	6/01/64	0.00	472.52	636.75
6-37-82A	7/28/64	0.00	473.02	636.75
6-37-82A	11/10/64	0.00	473.96	636.75
6-37-82A	1/15/65	0.00	473.79	636.75
6-37-82A	5/13/65	0.00	475.06	636.75
6-37-82A	8/16/65	0.00	475.34	636.75
6-37-82A	9/20/65	0.00	475.47	636.75
6-37-82A	10/18/65	0.00	475.77	636.75
6-37-82A	12/30/65	0.00	476.41	636.75
6-37-82A	3/02/66	0.00	476.71	636.75
6-37-82A	4/12/66	0.00	476.94	636.75
6-37-82A	5/18/66	0.00	476.77	636.75
6-37-82A	7/21/66	0.00	477.46	636.75
6-37-82A	10/28/66	0.00	478.06	636.75
6-37-82A	1/03/67	0.00	478.43	636.75
6-37-82A	3/28/67	0.00	479.19	636.75
6-37-82A	10/19/67	0.00	478.68	636.75
6-37-82A	3/20/68	0.00	478.15	636.75
6-37-82A	4/23/69	0.00	477.92	636.75
6-37-82A	5/12/70	0.00	476.99	636.75
6-37-82A	9/08/71	0.00	474.75	636.75
6-37-82A	3/09/72	0.00	474.55	636.75
6-37-82A	7/07/72	0.00	474.66	636.75
6-37-82A	10/15/72	0.00	474.05	636.75
6-37-82A	1/04/73	0.00	474.03	636.75
6-37-82A	4/10/73	0.00	473.74	636.75
6-37-82A	7/18/73	0.00	473.39	636.75
6-37-82A	8/15/73	0.00	473.38	636.75
6-37-82A	8/28/73	0.00	472.95	636.75
6-37-82A	9/14/73	0.00	473.05	636.75
6-37-82A	10/14/73	0.00	473.00	636.75
6-37-82A	10/18/73	0.00	473.09	636.75
6-37-82A	1/30/74	0.00	473.95	636.75
6-37-82A	4/18/74	0.00	473.89	636.75
6-37-82A	7/10/74	0.00	474.45	636.75

Table C.11. Water Level Data for Well 699-37-82A (Sheet 2 of 3).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
6-37-82A	1/08/75	0.00	474.72	636.75
6-37-82A	4/14/75	0.00	474.89	636.75
6-37-82A	7/07/75	0.00	474.81	636.75
6-37-82A	12/03/75	0.00	474.96	636.75
6-37-82A	6/15/76	0.00	474.81	636.75
6-37-82A	12/08/76	0.00	475.16	636.75
6-37-82A	7/01/77	0.00	475.34	636.75
6-37-82A	12/07/77	0.00	474.93	636.75
6-37-82A	6/01/78	0.00	475.17	636.75
6-37-82A	12/01/78	0.00	474.55	636.75
6-37-82A	6/01/80	0.00	473.62	636.75
6-37-82A	12/01/80	0.00	474.56	636.75
6-37-82A	6/01/81	0.00	473.58	636.75
6-37-82A	12/01/81	0.00	473.36	636.75
6-37-82A	6/01/82	0.00	473.14	636.75
6-37-82A	12/01/82	0.00	473.26	636.75
6-37-82A	12/15/82	473.26	0.00	636.75
6-37-82A	6/01/83	0.00	473.00	636.75
6-37-82A	6/15/83	473.00	0.00	636.75
6-37-82A	12/01/83	0.00	473.19	636.75
6-37-82A	12/15/83	473.16	0.00	636.75
6-37-82A	5/29/84	0.00	474.00	636.75
6-37-82A	5/29/84	474.00	0.00	636.75
6-37-82A	6/01/84	0.00	473.78	636.75
6-37-82A	6/11/84	0.00	473.89	636.75
6-37-82A	6/11/84	473.89	0.00	636.75
6-37-82A	6/15/84	473.78	0.00	636.75
6-37-82A	6/18/84	0.00	473.80	636.75
6-37-82A	6/18/84	473.80	0.00	636.75
6-37-82A	6/25/84	0.00	473.85	636.75
6-37-82A	6/25/84	473.85	0.00	636.75
6-37-82A	7/10/84	0.00	473.72	636.75
6-37-82A	7/10/84	473.72	0.00	636.75
6-37-82A	7/22/84	0.00	473.78	636.75
6-37-82A	7/23/84	473.78	0.00	636.75
6-37-82A	8/06/84	473.68	0.00	636.75
6-37-82A	8/19/84	0.00	473.76	636.75
6-37-82A	8/20/84	473.76	0.00	636.75
6-37-82A	9/04/84	0.00	474.09	636.75
6-37-82A	9/05/84	474.09	0.00	636.75
6-37-82A	9/16/84	0.00	473.81	636.75
6-37-82A	9/17/84	473.81	0.00	636.75
6-37-82A	10/01/84	473.86	0.00	636.75
6-37-82A	10/17/84	474.06	0.00	636.75

Table C.11. Water Level Data for Well 699-37-82A (Sheet 3 of 3).

Well Name	Date	Computed Head, ft above MSL	Hydraulic Head, ft above MSL	Casing Elevation, ft above MSL
6-37-82A	10/29/84	473.62	0.00	636.75
6-37-82A	11/19/84	473.60	0.00	636.75
6-37-82A	12/01/84	0.00	474.28	636.75
6-37-82A	12/10/84	474.11	0.00	636.75
6-37-82A	12/27/84	474.27	0.00	636.75
6-37-82A	1/08/85	473.88	0.00	636.75
6-37-82A	1/23/85	473.49	0.00	636.75
6-37-82A	2/04/85	473.24	0.00	636.75
6-37-82A	2/19/85	473.82	0.00	636.75
6-37-82A	3/05/85	473.66	0.00	636.75
6-37-82A	3/22/85	473.42	0.00	636.75
6-37-82A	4/02/85	473.10	0.00	636.75
6-37-82A	4/16/85	473.43	0.00	636.75
6-37-82A	5/02/85	473.40	0.00	636.75
6-37-82A	5/13/85	472.87	0.00	636.75
6-37-82A	5/27/85	473.13	0.00	636.75
6-37-82A	6/12/85	472.98	0.00	636.75
6-37-82A	6/12/85	472.98	0.00	636.75
6-37-82A	6/26/85	472.86	0.00	636.75
6-37-82A	7/09/85	472.71	0.00	636.75
6-37-82A	8/05/85	472.45	0.00	636.75
6-37-82A	12/27/85	472.01	0.00	636.75
6-37-82A	12/09/86	470.03	0.00	636.75
6-37-82A	9/23/87	469.67	0.00	636.75
6-37-82A	12/11/87	468.66	0.00	636.75
6-37-82A	12/15/87	469.38	0.00	636.75
6-37-82A	12/21/87	469.24	0.00	636.75
6-37-82A	8/26/88	468.94	0.00	636.75
6-37-82A	12/09/88	468.61	0.00	636.75
6-37-82A	5/05/89	468.37	0.00	636.75
6-37-82A	6/09/89	468.42	0.00	636.75

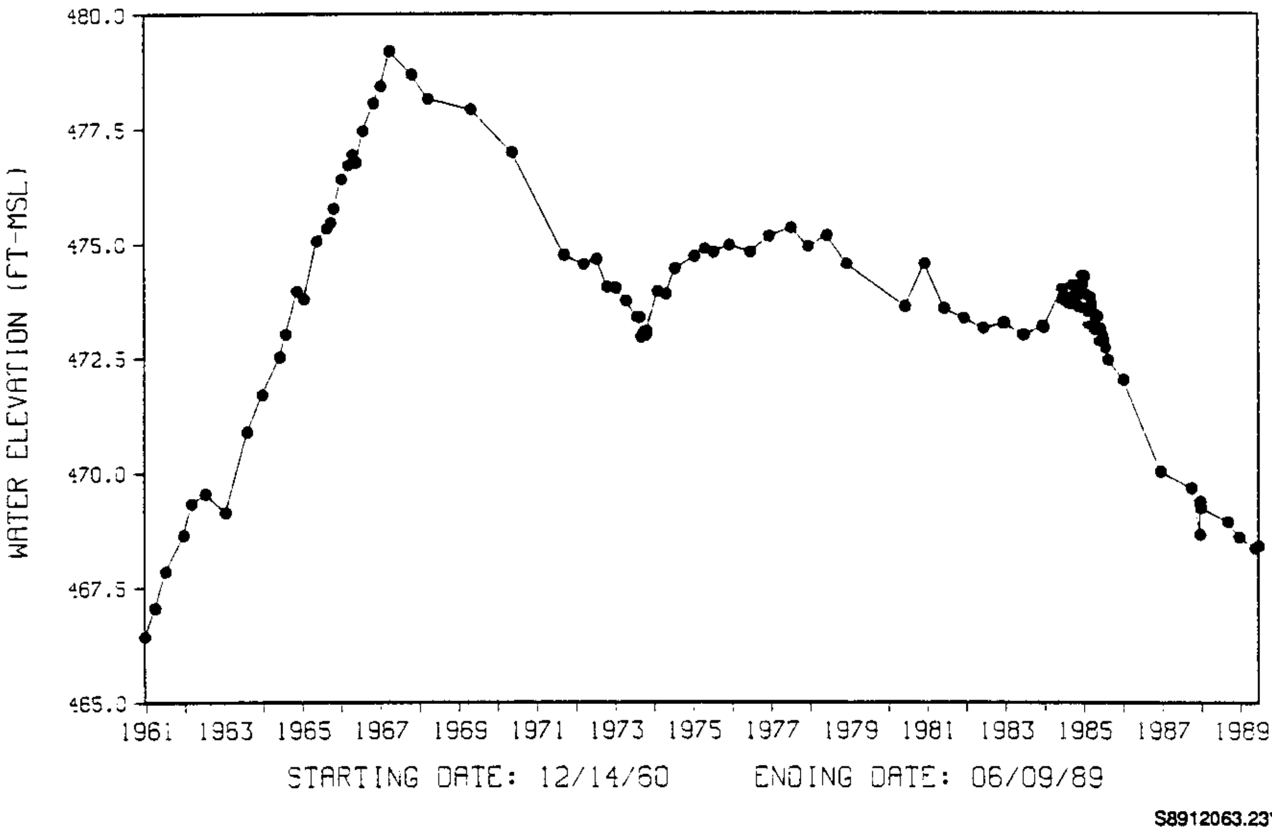

Figure C.11. Data for Well 699-37-82A.

APPENDIX D

WATER-CHEMISTRY DATA LISTINGS

APPENDIX D

WATER-CHEMISTRY DATA LISTINGS

This appendix presents an excerpt of existing water-chemistry data available for wells in the vicinity of 216-S-10 Ditch and Pond. The results of the analyses are listed in Table D.1. Table D.2 presents the full name of the analyzed constituents.

Table D.1. Results of Water Chemistry Analyses (Sheet 1 of 3).

Well Name	Collection Date	Constituent Name	Less Than Flag	Analysis Value	Analysis Units
2-W22-17	6/04/80	ALPHAHI		1.7000E+01	PCI/L
2-W22-17	6/04/80	BETA		7.5000E+01	PCI/L
2-W22-17	6/04/80	SR 90		2.8000E+00	PCI/L
2-W26-3	2/11/88	ALPHA		1.1400E+00	PCI/L
2-W26-3	2/11/88	BETA		2.7900E+00	PCI/L
2-W26-3	2/11/88	HNITRAT	<	2.5000E+03	PPB
2-W26-3	2/11/88	TRITIUM	<	1.2100E+02	PCI/L
2-W26-3	9/28/88	ALPHA		7.6300E-01	PCI/L
2-W26-3	9/28/88	BETA		2.9000E+00	PCI/L
2-W26-3	9/28/88	HNITRAT	<	2.5000E+03	PPB
2-W26-3	9/28/88	TRITIUM	<	-8.6200E+01	PCI/L
2-W26-6	2/11/88	ALPHA		1.2500E+00	PCI/L
2-W26-6	2/11/88	BETA		6.5600E+00	PCI/L
2-W26-6	2/11/88	CO-60	<	3.9400E+00	PCI/L
2-W26-6	2/11/88	CS-137	<	-1.8600E+00	PCI/L
2-W26-6	2/11/88	HNITRAT	<	2.5000E+03	PPB
2-W26-6	2/11/88	RU-106	<	-3.8100E+01	PCI/L
2-W26-6	2/11/88	SR 90	<	-2.3800E-01	PCI/L
2-W26-6	2/11/88	TRITIUM	<	-4.8400E+01	PCI/L
2-W26-6	9/28/88	ALPHA		9.5400E-01	PCI/L
2-W26-6	9/28/88	BETA		5.6500E+00	PCI/L
2-W26-6	9/28/88	CO-60	<	-1.5700E+00	PCI/L
2-W26-6	9/28/88	CS-137	<	1.4400E+00	PCI/L
2-W26-6	9/28/88	HNITRAT		3.3100E+03	PPB
2-W26-6	9/28/88	RU-106	<	1.5300E+01	PCI/L
2-W26-6	9/28/88	SR 90	<	-5.6000E-01	PCI/L
2-W26-6	9/28/88	TRITIUM		1.4500E+03	PCI/L
6-29-78	3/29/89	I-129DW	<	7.3500E-02	PCI/L
6-29-78	4/21/89	ALPHAHI	<	8.7200E-01	PCI/L
6-29-78	4/21/89	BETA		3.9400E+00	PCI/L
6-29-78	4/21/89	HNITRAT		7.8000E+03	PPB
6-29-78	4/21/89	TRITIUM		2.2800E+02	PCI/L
6-32-72	1/20/89	ALPHA	<	-2.2300E-01	PCI/L
6-32-72	1/20/89	BETA		1.2300E+01	PCI/L
6-32-72	1/20/89	I-129DW	<	2.9000E-02	PCI/L
6-32-72	1/20/89	TC-99		8.6400E+01	PCI/L
6-32-72	4/24/89	ALPHAHI	<	6.4200E-01	PCI/L
6-32-72	4/24/89	BETA		1.1800E+01	PCI/L
6-32-72	4/24/89	CO-60	<	3.9700E+00	PCI/L
6-32-72	4/24/89	CS-137	<	-1.0600E+00	PCI/L

Table D.1. Results of Water Chemistry Analyses (Sheet 2 of 3).

Well Name	Collection Date	Constituent Name	Less Than Flag	Analysis Value	Analysis Units
6-32-72	4/24/89	HNITRAT		6.6000E+03	PPB
6-32-72	4/24/89	RU-106	<	-9.9300E+00	PCI/L
6-32-72	4/24/89	SR 90	<	-7.7600E-02	PCI/L
6-32-72	4/24/89	TRITIUM		1.4000E+05	PCI/L
6-32-72	4/24/89	U		2.6300E-01	PCI/L
6-32-77	1/20/89	I-129DW	<	-3.9500E-03	PCI/L
6-32-77	4/24/89	ALPHAHI	<	4.8800E-01	PCI/L
6-32-77	4/24/89	BETA		4.3500E+00	PCI/L
6-32-77	4/24/89	CO-60		9.9300E+00	PCI/L
6-32-77	4/24/89	CS-137	<	-2.8600E+00	PCI/L
6-32-77	4/24/89	HNITRAT		5.8000E+03	PPB
6-32-77	4/24/89	RU-106	<	2.4000E+01	PCI/L
6-32-77	4/24/89	TRITIUM	<	6.4100E+01	PCI/L
6-35-78A	1/12/89	ALKALIN		9.6000E+04	
6-35-78A	1/12/89	BROMIDE	<	1.0000E+03	PPB
6-35-78A	1/12/89	CHLORID		3.1000E+03	PPB
6-35-78A	1/12/89	CONDFLD		1.7900E+02	UMHO
6-35-78A	1/12/89	FALUMIN	<	1.5000E+02	PPB
6-35-78A	1/12/89	FANTIMO	<	1.0000E+02	PPB
6-35-78A	1/12/89	FBARIUM		1.4000E+01	PPB
6-35-78A	1/12/89	FBERYLL	<	5.0000E+00	PPB
6-35-78A	1/12/89	FBORON		2.1000E+01	PPB
6-35-78A	1/12/89	FCADMIU	<	2.0000E+00	PPB
6-35-78A	1/12/89	FCALCIU		1.7100E+04	PPB
6-35-78A	1/12/89	FCHROMI		1.3000E+01	PPB
6-35-78A	1/12/89	FCOBALT	<	2.0000E+01	PPB
6-35-78A	1/12/89	FCOPPER	<	1.0000E+01	PPB
6-35-78A	1/12/89	FIRON		4.5000E+01	PPB
6-35-78A	1/12/89	FLITHIU	<	1.0000E+01	PPB
6-35-78A	1/12/89	FLUORID	<	5.0000E+02	PPB
6-35-78A	1/12/89	FMAGNES		5.4800E+03	PPB
6-35-78A	1/12/89	FMANGAN	<	5.0000E+00	PPB
6-35-78A	1/12/89	FMOLY	<	4.0000E+01	PPB
6-35-78A	1/12/89	FNICKEL	<	1.0000E+01	PPB
6-35-78A	1/12/89	FPOTASS		2.4300E+03	PPB
6-35-78A	1/12/89	FSILICO		1.4500E+04	PPB
6-35-78A	1/12/89	FSILVER	<	1.0000E+01	PPB
6-35-78A	1/12/89	FSODIUM		1.6700E+04	PPB
6-35-78A	1/12/89	FSTRONT		6.8000E+01	PPB
6-35-78A	1/12/89	FTIN	<	3.0000E+01	PPB

Table D.1. Results of Water Chemistry Analyses (Sheet 3 of 3).

Well Name	Collection Date	Constituent Name	Less Than Flag	Analysis Value	Analysis Units
6-35-78A	1/12/89	FTITAN	<	6.0000E+01	PPB
6-35-78A	1/12/89	FVANADI		1.9000E+01	PPB
6-35-78A	1/12/89	FZINC		5.0000E+00	PPB
6-35-78A	1/12/89	FZIRCON	<	5.0000E+01	PPB
6-35-78A	1/12/89	NITRATE		5.0000E+02	PPB
6-35-78A	1/12/89	NITRITE	<	1.0000E+03	PPB
6-35-78A	1/12/89	PH-LAB		8.1000E+00	
6-35-78A	1/12/89	PHFIELD		7.6000E+00	
6-35-78A	1/12/89	PHOSPHA	<	1.0000E+03	PPB
6-35-78A	1/12/89	SULFATE		1.1100E+04	PPB
6-35-78A	1/12/89	TC		2.0200E+04	PPB
6-35-78A	1/12/89	TOC	<	4.0000E+02	PPB
6-35-78A	2/09/89	ALPHA		1.5400E+01	PCI/L
6-35-78A	2/09/89	BETA		4.2400E+00	PCI/L
6-35-78A	2/09/89	CO-60	<	-1.9600E-01	PCI/L
6-35-78A	2/09/89	CS-137	<	-1.6800E+00	PCI/L
6-35-78A	2/09/89	HNITRAT	<	2.5000E+03	PPB
6-35-78A	2/09/89	RU-106	<	-2.2200E+01	PCI/L
6-35-78A	2/09/89	TRITIUM	<	1.1900E+01	PCI/L
6-35-78A	2/09/89	U-234		9.5900E+00	PCI/L
6-35-78A	2/09/89	U-235		5.1500E-01	PCI/L
6-35-78A	2/09/89	U-238		9.6700E+00	PCI/L
6-35-78A	2/09/89	U-CHEM		2.5100E+01	UG/L
6-35-78A	4/24/89	ALPHAHI		1.2900E+01	PCI/L
6-35-78A	4/24/89	BETA		4.4800E+00	PCI/L
6-35-78A	4/24/89	CO-60	<	2.2700E+00	PCI/L
6-35-78A	4/24/89	CS-137	<	1.3700E+00	PCI/L
6-35-78A	4/24/89	HNITRAT	<	2.5000E+03	PPB
6-35-78A	4/24/89	RU-106	<	3.2400E+01	PCI/L
6-35-78A	4/24/89	TRITIUM	<	-6.1200E+01	PCI/L
6-35-78A	4/24/89	U-234		1.0700E+01	PCI/L
6-35-78A	4/24/89	U-235		3.8500E-01	PCI/L
6-35-78A	4/24/89	U-238		1.0200E+01	PCI/L
6-35-78A	4/24/89	U-CHEM		2.8100E+01	UG/L

Table D.2. Full Name of Analyzed Constituents (Sheet 1 of 2).

Constituent Name	Constituent Full Name
ALKALIN	Alkalinity
ALPHA	Gross alpha
ALPHAHI	Alpha, High Detection Level
BETA	Gross beta
BROMIDE	Bromide
CHLORID	Chloride
CO-60	Cobalt-60
CONDFLD	Specific conductance
CS-137	Cesium-137
FALUMIN	Aluminum, filtered
FANTIMO	Antimony, filtered
FBARIUM	Barium, filtered
FBERYLL	Beryllium, filtered
FBORON	Boron, filtered
FCADMIU	Cadmium, filtered
FCALCIU	Calcium, filtered
FCHROMI	Chromium, filtered
FCOBALT	Cobalt, filtered
FCOPPER	Copper, filtered
FIRON	Iron, filtered
FLITHIU	Lithium, filtered
FLUORID	Fluoride
FMAGNES	Magnesium, filtered
FMANGAN	Manganese, filtered
FMOLY	Molybdenum, filtered
FNICKEL	Nickel, filtered
FPOTASS	Potassium, filtered
FSILICO	Silicon, filtered
FSILVER	Silver, filtered
FSODIUM	Sodium, filtered
FSTRONT	Strontium, filtered
FTIN	Tin, filtered
FTITAN	Titanium, filtered
FVANADI	Vanadium, filtered
FZINC	Zinc, filtered
FZIRCON	Zirconium, filtered
HNITRAT	Nitrate, High Detection Level
I-129DW	
NITRATE	Nitrate
NITRITE	Nitrite
PH-LAB	pH, Laboratory Measurement

Table D.2. Full Name of Analyzed Constituents (Sheet 2 of 2).

Constituent Name	Constituent Full Name
PHFIELD	pH, Field Measurement
PHOSPHA	Phosphate
RU-106	Ruthenium-106
SR 90	Strontium-90
SULFATE	Sulfate
TC	Total carbon
TC-99	Technetium-99
TOC	Total organic carbon
TRITIUM	Tritium
U	Uranium
U-234	Uranium-234
U-235	Uranium-235
U-238	Uranium-238
U-CHEM	Natural uranium

APPENDIX E

SAMPLING AND ANALYSIS PLAN

APPENDIX E

SAMPLING AND ANALYSIS PLAN

This appendix introduces the procedures that will be used for sample collection (including well evacuation and sample withdrawal methods); chain of custody; analytical methods, including samples preservation, shipment, and chemical analysis; and quality assurance/quality control.

All sampling activities are currently performed under contract by Pacific Northwest Laboratory (PNL). United States Testing Company, Inc., (UST) currently conducts sample analyses for most constituents.

SAMPLE COLLECTION PROCEDURES

The procedures for ground-water sample collection, water-level measurements, and field measurements are contained in Procedures for Ground-Water Investigations (PNL 1989). Specific applicable procedures include the following:

- GC-1 - Ground-Water Sample Collection Procedure
- GC-2 - In-Line Sample Filtration Procedure
- GC-3 - Disposal of Purge Water from Monitoring Wells
- FA-1 - Temperature Measurement Procedure
- FA-2 - Calibration of Conductivity Meter and Measurement of Field Conductivity
- FA-3 - Calibration of pH Meter and Measurement of Field pH
- WL-1 - Water-Level Measurement Procedure
- WL-2 - Procedure for Standardizing Steel Tapes.

Table E.1. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Listed Constituents as of January 1, 1989. (Sheet 1 of 4)

CONSTITUENT	COLLECTION AND PRESERVATION(a,b)	ANALYSIS METHODS(c)	DETECTION LIMIT, PPB(d)
Metals Analyzed by the Inductively Coupled Plasma Method--Unfiltered/Filtered			
beryllium			3
strontium			10
zinc			5
calcium			50
barium			6
cadmium			5
chromium			10
silver			10
sodium			200
nickel			10
copper			10
vanadium	P, HNO_3 to pH<2	SW-846, #6010	5
antimony			100
aluminum			150
manganese			5
potassium			100
iron			30
magnesium			50
boron			10
cobalt			20
lithium			10
molybdenum			40
silicon			50
tin			30
titanium			60
zirconium			50
arsenic	P, HNO_3 to pH<2	SW-846, #7060	5
mercury	G, HNO_3 to pH<2	SW-846, #7470	0.1
selenium	P, HNO_3 to pH<2	SW-846, #7740	5
lead	P, HNO_3 to pH<2	SW-846, #7421	5
Anions by Ion Chromatography			
nitrate			500
sulfate			500
fluoride	P, none		500
chloride		(e)	500
phosphate			1000

Table E.1. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Listed Constituents as of January 1, 1989. (Sheet 2 of 4)

CONSTITUENT	COLLECTION AND PRESERVATION[a,b]	ANALYSIS METHODS[c]	DETECTION LIMIT, PPB[d]
bromide			1000
nitrite			1000
Pesticides			
endrin	G, none	SW-846, #8080	0.1
methoxychlor			3
toxaphene			1
lindane (four isomers)			0.1
Herbicides			
2,4-D	G, none	SW-846, #8150	2
2,4-5-TP silvex			2
2,4,5-T			2
Volatile Organic Analyses (VOA)			
carbon tetra-chloride	G, no headspace	SW-846, #8240	5
benzene			5
methyl ethyl ketone			10
toluene			5
1,1,1-trichloro-ethane			5
1,1,2-trichloro-ethane			5
trichloroethylene			5
tetrachloroethylene			5
xylene (O, P)			5
chloroform			5
1,1-dichloroethane			5
1,2-dichloroethane			5
trans-1,2 dichloroethylene			5
methylene chloride			5
vinyl chloride			10
xylene (M)			5

Table E.1. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Listed Constituents as of January 1, 1989. (Sheet 3 of 4)

CONSTITUENT	COLLECTION AND PRESERVATION[a,b]	ANALYSIS METHODS[c]	DETECTION LIMIT, PPB[d]
p-dichlorobenzene			5
methyl isobutyl ketone			10
acetone			10
tetrahydrofuran			10
Radiological			
radium	P, HNO_3 to pH<2	SW-846, #9315[f]	1 pCi/L
gross alpha	P, HNO_3 to pH<2	SW-846, #9310	4 pCi/L
gross beta	P, HNO_3 to pH<2	SW-846, #9310	8 pCi/L
tritium	P, none	ASTM, D2476-81	500 pCi/L
uranium	P, HNO_3 to pH<2	(g)	
uranium	P, HNO_3 to pH<2	(h)	
gamma scan	P, HNO_3 to pH<2	(i)	
Other			
coliform bacteria	P, none	SW-846, #9131	2.2[j]
temperature	field measurement	(k)	
specific conductance	field measurement	(k)	
pH	field measurement	(k)	
total organic halogen, low detection level	G, H_2SO_4 to pH<2 No headspace	SW-B846, #9020	10
total organic carbon	G, H_3PO_4 to pH<2	SW-846, #9060	2000
total carbon	G, none	SW-846, #9060	2000
ammonium ion	G, H_2SO_4 to pH<2	ASTM D1426-D[l]	50
phenol	G, none	SW-846, #8040	10
cyanide	P, NaOH to pH<2	SW-846, #9010	10
hydrazine	G, HCl	ASTM D1385	30
total dissolved	P, none	Std. Methods 209B[m]	--

(a) P, plastic; G, glass.
(b) All samples will be cooled to 4°C upon collection.
(c) Constituents grouped together are analyzed by the same method.
(d) Detection limit units except where indicated.
(e) Analytical method adapted Method 300.0, EPA (1984).

Table E.1. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Listed Constituents as of January 1, 1989. (Sheet 4 of 4)

(f) The method also references ASTM (1988) and Krieger and Whittaker (1980).
(g) Adopted from Techniques of Water Resources Investigations of the U.S. Geological Survey, as amended, U.S. Government Printing Office, Washington, D.C.
(h) Adopted from NCRP (1985).
(i) From Krieger and Whittaker (1980) and Volchok and de Planque (1983).
(j) Most probable number.
(k) PNL (1989).
(l) By ion selective electrode.
(m) APHA (1985).

Table E.2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and 40 CFR 264 Lists[a]. (Sheet 1 of 5)

CONSTITUENT	COLLECTION AND PRESERVATION[b,c]	ANALYSIS METHODS[d]	DETECTION LIMIT, PPB[e]
Metals, Analyzed by the Inductively Coupled Plasma Method--Enhanced Additions			
thallium	P, HNO_3 to pH<2	SW-846, #7840	5
Thiourea Group--Enhanced Additions			
thiourea	G, none	SW-846, #8330 (modified)	200
1-acetyl-2-thiourea			200
1-(o-chlorophenyl) thiourea			200
diethylstilbestrol			200
ethylenethiourea			200
1-naphthyl-2-thiourea			200
N-phenylthiourea			500
Pesticides--Enhanced Additions			
aldrin	G, none	SW-846, #8080	0.1
chlordane			1
4,4'DDD			0.1
4,4'DDE			0.1
4,4'DDT			0.1
endosulfan I			0.1
endosulfan II			0.1
endosulfan sulfate			0.5
heptachlor			0.1
heptachlor epoxide			0.1
kepone			1
dieldrin			0.1
chlorobenzilate			300
Phosphorous Pesticides			
carbophenothion			2
tetraethylpyrophosphate			2
disulfoton			2

Table E.2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and 40 CFR 264 Lists[a]. (Sheet 2 of 5)

CONSTITUENT	COLLECTION AND PRESERVATION[b,c]	ANALYSIS METHODS[d]	DETECTION LIMIT, PPB[e]
dimethoate	G, none	SW-846, #8140	2
methyl parathion			2
parathion			2
phorate			2
Direct Aqueous Injection			
acrylamide	G, none	SW-846, #8240[f]	10,000
allyl alcohol			2,500
chloroacetaldehyde			16,000
3-chloropropionitrile			4,000
ethyl carbamate			5,000
ethyl cyanide			2,000
ethylene glycol			10,000
isobutyl alcohol			1,000
paraldehyde			2,000
N-propylamine			10,000
2-propyn-1-ol			8,000
Dioxins			
PCDDs	G, none	SW-846, #8280	0.01
PCDFs			0.01
2,3,7,8 TCDD			0.01
Volatile Organic Analyses--Enhanced Additions			
1,4-dioxane			500
pryidine			500
acrolein			10
acrylonitrile			10
bis(chloromethyl) ether			5
bromoacetone			5
methyl bromide			10
carbon disulfide			10
chlorobenzene			5

Table E.2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and 40 CFR 264 Lists[a]. (Sheet 3 of 5)

CONSTITUENT	COLLECTION AND PRESERVATION[b,c]	ANALYSIS METHODS[d]	DETECTION LIMIT, PPB[e]
2-chloroethyl vinyl ether			5
methyl chloride			10
chloromethyl methyl ether	G, no headspace	SW-846, #8240	5
crotonaldehyde			10
1,2-dibromo-3-chloropropane			10
1,2-dibromoethane			10
dibromomethane			10
1,4-dichloro-2-butene			10
dichlorodifluoromethane			10
1,2-dichloropropane			5
N-N-diethylhydrazine			10
1,1-dimethylhydrazine			10
1,2-dimethylhydrazine			10
iodomethane			10
methacrylonitrile			10
methanethiol			10
pentachloroethane			10
1,1,2,2-tetrachloroethane			5
bromoform			5
trichloromethanethiol			10
trichloromonofluoromethane			10
1,2,3-trichloropropane			10
acetonitrile			10
formaldehyde	G, no headspace	SW-846, #8240	500
ethylene oxide			10
ethylmethacrylate			10
ethyl benzene			5
styrene			5

Table E.2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and 40 CFR 264 Lists[a]. (Sheet 4 of 5)

CONSTITUENT	COLLECTION AND PRESERVATION[b,c]	ANALYSIS METHODS[d]	DETECTION LIMIT, PPB[e]
bromodichloromethane			5
dibromochloromethane			5
2-hexanone			50
1,3-dichloropropene			5
allyl chloride			100
chloroethane			10
propionitrile			5
vinyl acetate			5
additional targeted compounds[g]			
additional VOAs[h]			
SEMIVOLATILE ORGANIC ANALYSIS (Acid/Base/Neutral)			
chlorobenzene	G, none	SW-846, #8270	10
cresols			10
1,2-dichlorobenzene			10
1,3-dichlorobenzene			10
p-dichlorobenzene			10
hexachlorobenzene			10
pentachlorobenzene			10
pentachlorophenol			50
1,2,4,5-tetrachlorobenzene			10
1,2,4-trichlorobenzene			10
hexachlorophene			10
naphthalene			10
1,2,3-trichlorobenzene			10
phenol			10
1,3,5-trichlorobenzene			10
1,2,3,4-tetra chlorobenzene			10
1,2,3,5-tetra chlorobenzene			10
kerosene			10
strychnine			50

Table E.2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and 40 CFR 264 Lists[a]. (Sheet 5 of 5)

CONSTITUENT	COLLECTION AND PRESERVATION[b,c]	ANALYSIS METHODS[d]	DETECTION LIMIT, PPB[e]
maleic hydrazide	G, none	SW-846, #8270	500
nicotinic acid			100
tributylphosphate			10
additional semivolatiles[i]			
OTHER			
polychlorinated biphenyls	G, none	SW-846, #8080	1
perchlorate	P, none	70-IC[j]	500
sulfide	P, NaOH/zinc acetate	SW-846, #9030	1,000
citrus red no. 2	G, none	AOAC #34.015B[k]	1,000

(a) WAC 173-303-9905, "Dangerous Waste Constituent List;" and 40 CFR 264, Appendix IX, "Ground-Water Monitoring List."
(b) P, plastic; G, glass.
(c) All samples will be cooled to 4°C upon collection.
(d) Constituents grouped together are analyzed by the same method.
(e) Detection limit units except where indicated.
(f) Direct aqueous injection.
(g) Additional list of targeted compounds. Constituents on the "Dangerous Waste Constituent List" (WAC 173-303-9905).
(h) Tentatively identified compounds are listed when detected, but there are no established detection limits for these.
(i) There are more than 100 additional semivolatile compounds on the "long list" that are not listed here. Most of these analyses have a detection level of 10 ppb.
(j) Analytical method, adapted from Method 300.0, EPA (1984).
(k) Association of Official Analytical Chemists (1980).

CHAIN-OF-CUSTODY PROCEDURES

Chain-of-custody procedures are contained in Procedures for Ground-Water Investigations (PNL 1989). The specific applicable procedure is AD-2, Ground-Water Sample Chain-of-Custody Procedure. The history of the custody of each sample will be documented according to this procedure.

QUALITY ASSURANCE/QUALITY CONTROL

Quality Assurance

Quality assurance (QA) will be conducted in accordance with the PNL quality assurance manual. A QA plan describing the manner in which specific QA requirements are to be met has been prepared in accordance with that manual.

Quality Control

The purpose of quality control (QC) is to determine and document the quality of the analytical results being produced by the laboratory and to bring potential problems with analyses to the attention of UST for corrective actions as needed. The QC effort has two main components: 1) routine internal checks performed by UST, and 2) external checks conducted by PNL to independently evaluate UST performance. The scope of these efforts is described in the following sections.

United States Testing Company, Incorporated, Internal Quality Control. Internal quality control at UST includes general practices applicable to a wide range of analyses, as well as specific procedures stipulated for particular analyses. The quality control and quality assurance programs at UST are documented in a quality control manual and a quality assurance manual. UST produces a quarterly quality control report to PNL, which includes blank, matrix, spike, and surrogate data.

UST External Quality Control. Pacific Northwest Laboratory will use interlaboratory comparisons, replicate, blank, and blind samples to evaluate the accuracy of results from UST. The purpose and scope of each of these is as follows.

Interlaboratory comparisons using field samples are conducted to determine if the results obtained by the primary laboratory, UST, are comparable to those obtained from other laboratories. Comparisons are currently being conducted for anions, selected volatile organic constituents, metals, cyanide, gross alpha, gross beta, and tritium. Each month, replicate samples from selected wells are delivered to four different PNL laboratories. The results from these PNL laboratories are then compared with the results from UST. Samples sent to PNL laboratories are from the same sampling set as those to be analyzed in duplicate by UST.

Replicate analyses of field samples are conducted to establish how much variability might be expected in the laboratory measurements performed on nearly identical samples and as a check for gross errors. Blanks for a wide range of analyses are submitted to UST monthly to check for container or laboratory contamination.

Trip (transport) blanks and transfer blanks are submitted to UST to determine whether environmental conditions encountered during collection and transportation of samples have affected the results obtained by analysis. One set of trip blanks and transfer blanks are submitted each sample period per sample area at the rate of at least one for 1 to 20 wells. These blanks are analyzed for volatile organic constituents.

Blind samples are submitted to UST to estimate the bias of analytical laboratory procedures and to determine when this bias exceeds control limits. Blind standard samples prepared by PNL containing metals, anions, herbicides, pesticides, and volatile organic compounds have been submitted quarterly since January 1986. Most blind samples are now prepared with materials supplied by the U.S. Environmental Protection Agency (EPA), including the previous list of analytes plus ammonium ion, cyanide, semivolatile compounds, PCBs, and an expanded number of pesticides and volatile organic compounds. Samples containing constituents not available in EPA performance samples are prepared from high-quality chemicals. These include constituents from the enhanced thiourea and phosphorous pesticides group analyses, plus ethylene glycol, sulfide, perchlorate, and hydrazine dioxin (TCDD).

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